SAE Journal

JANUARY 1952

PUBLISHED BY THE SOCIETY OF AUTOMOTIVE ENGINEERS

Mr. Basic Bearing has quite a Wardrobe
With One Shield
With Two Shields
With Snap Ring
With One Seal
With Two Seals
Basic Single Row Ball Bearing
The right "dress" for every job — available as accessories to New Departure's basic ball bearing.
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Nothing Rolls Like a Ball...
NEW DEPARTURE
BALL BEARINGS
NEW DEPARTURE · DIVISION OF GENERAL MOTORS · BRISTOL, CONNECTICUT
157

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ALCOA invites you...
... to visit its booth, Parlor C, at the S. A. E. Engineering Display, January 14-18, Sheraton Cadillac Hotel, Detroit, Mich.
... to see the latest and most significant uses of aluminum for the automotive industry.
... to discuss these applications with Alcoa technical personnel.
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New alumilite finishes & new aluminum-pigmented enamels.
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Coiled tube combines easy workability, high fatigue strength, long lengths, and low cost.
AUTOMOTIVE WIRE
Samples of aluminum insulated wire used in automotive wiring. Demonstrations of new welding methods for joining electrical wiring.
BRAZED CYLINDER HEADS and CRANKCASES
Samples of cylinder heads and crankcases that are cast in sections and brazed together.
BRAZED ALUMINUM RADIATORS
Samples of brazed thin gauge aluminum heat exchangers and various aluminum radiator materials.
ALCOA
ALUMINUM

"Partners in Creating"

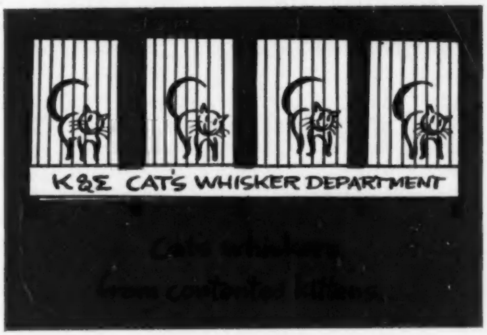
When K&E coined the phrase "Partners in Creating," they of course meant not themselves but their products. And it's true that K&E products have been in with engineers, scientists, draftsmen and architects on the

The K&E trade mark for decades, and the more modern one adopted in recent years.

creation of most of the big man-built wonders of the world for over 4/5 of a century.

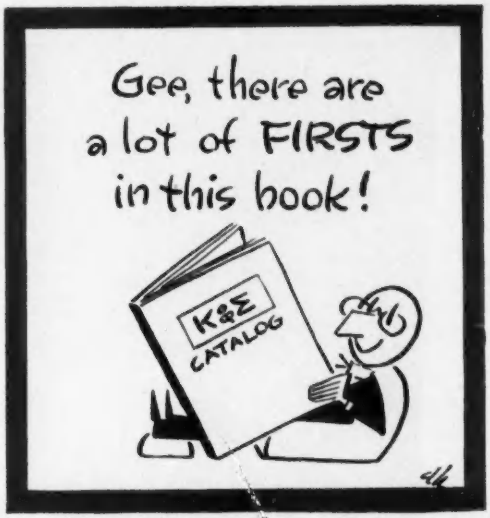
Zippy at 84

K&E have remained alert and alive, as is evidenced by their unending originality and inventiveness. They made America's first slide rules, as far back as 1891. And in both world wars, they did a big development job on optical equipment for our fighting men—on vital things such as periscopes, fire control instruments and height finders. The K&E catalog is full of "firsts"—some of them plenty recent, such as Wyteface* Measuring Tapes and Leroy† Lettering Equipment. No wonder it's the engineers' encyclopedia.

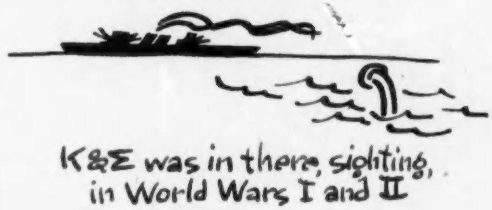


Factories within a Factory

K&E headquarters are a town within a town, many factories within a factory. In one area they're coating miles of papers and cloths. In another they're turning screws so tiny you feel like a hippopotamus if you try to pick one up. Here they're grinding optical lenses.

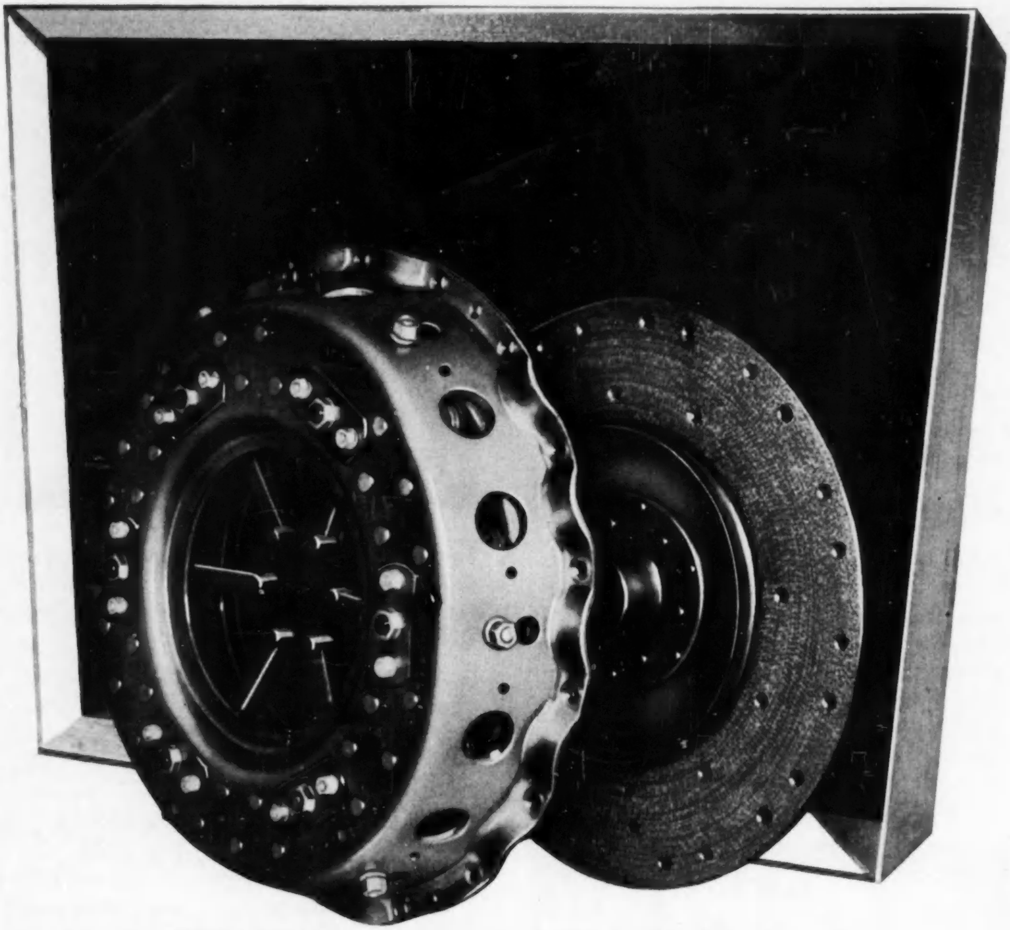


There they're putting graduations no bigger than a fly's kneecap on scales of some sort. Here they're doing fastidiously fine leather work. There they're reeling off steel measuring tapes by the mile.



But wherever you go you are aware of the age-old passion for precision and quality. And I'm not the least bit sorry that today I haven't sold you a single K&E product. I've just tried a little bit to sell you on the people at K&E—and to get you to believe that you can safely make K&E products trusted partners in your own creative work.

*Trade Mark
†Trade Mark ®



BUSINESS IN MOTION

To our Colleagues in American Business . . .

The fact that a Revere Distributor is now celebrating its 125th anniversary year is an indication of the service the company has given its customers through those years. It is also another proof of the essential function performed by distributors for American industry. Most goods, whether industrial materials such as copper and copper alloys, aluminum alloys, iron and steel, or consumer articles such as refrigerators, radio and television receivers, kitchen utensils and ranges, go through the hands of distributors. Generally speaking, only the large buyers are in a position to purchase direct from manufacturers, who do not find it economical to handle the smaller orders. Yet those orders when pooled in the hands of an organization set up to handle them attain sizable totals, and hence a good distributor account is exceedingly attractive to a large manufacturer such as Revere.

A distributor serves not only the factories from which he buys. He also performs an invaluable service to his customers by making quickly available to them the products they require. A machine shop, for example, may need only a few hundred pounds of brass rod; there is a distributor within easy reach who can furnish it almost immediately. Or a contractor may want a few pieces of steel pipe and a thousand feet or so of copper water tube. Again, the distributor has them. A metal products distributor has to carry such items and an infinite number of others. The Revere Distributor who started in business 125 years ago actually has in stock 53,000 different items, cataloged, indexed, and held in warehouses ready for immediate shipment throughout its territory. Each month this stock is drawn upon by 5,000 to 8,000 customers, each order relatively small. There are many Revere Distributors with similar stocks and offering equal service.

To keep this distributor's warehouses filled with a balanced inventory, 18 people are required in his purchasing staff, which includes specialists in various kinds of materials, machines, tools and supplies. And to serve customers with information, quotations and the like, 25 salesmen are on the go constantly, calling on manufacturers, contractors, builders and stores throughout the busy industrial area in which the distributor operates. The large business done by the company is in great contrast to that of 125 years ago, when it was little more than a hardware store. The enterprise has grown in the American tradition of freedom to prosper in accordance with the principles of reliability and efficiency, fair dealing and integrity in performing a desired function.

Revere Distributors are selected for their ability to serve, and also chosen as to location, so that no matter where you are in this big country of ours, there is a Revere Distributor within easy reach. Today metal stocks may be short due to defense demands but manufacturers are doing everything possible to keep distributors supplied.

If you buy from distributors we suggest you remember that they are not only "central stockrooms," but have a great deal of special knowledge about the products they sell and can give you much helpful advice. Not only that, through the Revere Distributors you can be put in touch with the Revere Technical Advisory Service, which will cooperate with you on matters concerning the selection and fabrication of the Revere Metals. Our distributors, and those of every other manufacturer, render many essential services, both to those to whom they sell, and to those from whom they buy. The distributor system as it operates in the United States arose in response to the need for it. Today it fulfills that need more effectively than ever before.

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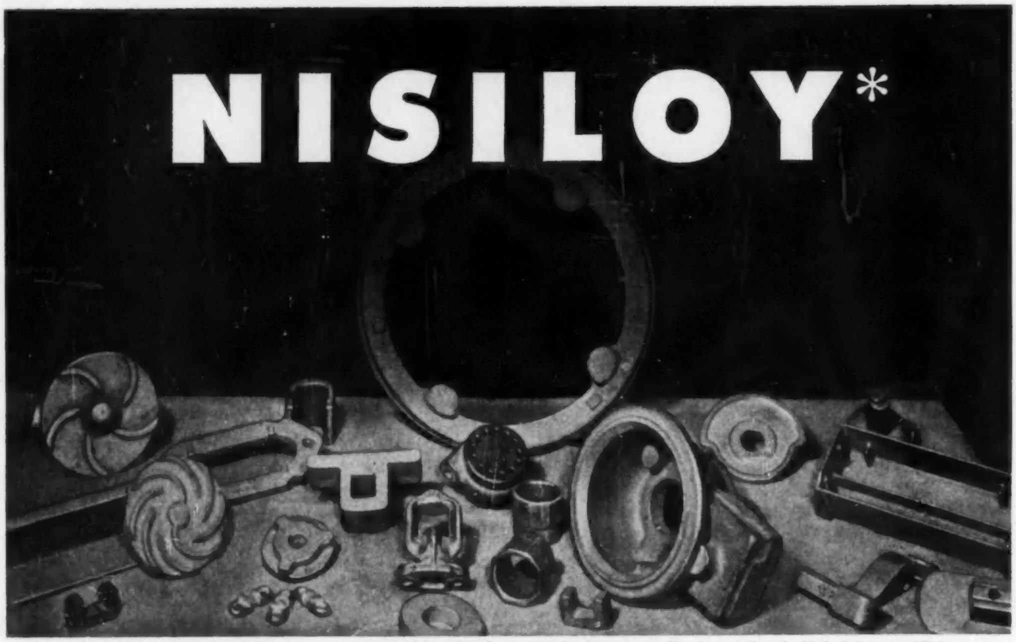

Chilling and consequent machining difficulties were encountered by a foundry specializing in cast parts like these, designed with both heavy and light sections. Nisiloy, added to the ladle, assured ready machinability after many other experiments failed.

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For the Sake of Argument

Variation on a Theme—"Security" . . .

By Norman G. Shidle

"The nearest anybody can come to security is to acquire ability to meet changing conditions" . . . and change is something nobody can outline in detail ahead of time. We can be sure it will occur but we must remain eternally unsure of its direction, character, and amplitude.

That train of thought chugs back to the conclusion that security must be of the mind . . . not of the income, the property or the occupation. Worrying about the details doesn't help now or later. "The trouble with worrying so much about your security in the future," as Harlan Mitler says, "is that you feel so insecure in the present." And when you arrive in the future you're worrying about, it will be, of course, the present—and you'll probably still be feeling insecure.

"Only those ideas in which we have faith ever reach complete expression," Charles Filmore wrote the other day. His expression points up the security available for those with faith in their capacity to work in harmony with a future different from the past.

This kind of security is of the present . . . the ever-present now. Once acquired, it is permanent. Its possessor beckons change as a friend; no longer fears it as a mystery.

Secure is the man with confidence in his ability to find the answers . . . more secure than the man merely strong in his own knowledge. Secure is the man who carries unfinished business around in his heart . . . whose projects stretch happily ahead, farther than he can see. Secure is the man who can sing with Tennyson: "Let the old world spin forever down the ringing grooves of change."

"The surest way to lose security is to think you can get it . . . or to seek it . . . outside yourself."

SAE Journal

Norman G. Shidle
Editor

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Daniel P. Barnard IV

1952 SAE President

DR. DANIEL P. BARNARD IV, research coordinator of Standard Oil Co. (Indiana), has a long record of achievements in trying to fit fuels to engines—which to him is one problem, not two. In the words of SAE's Horning Memorial award, which was presented to Dr. Barnard in 1949, he has given "distinguished active service in the field of mutual adaptation of fuels and engines."

Dan Barnard's lifelong interest in engines and fuels began early. As a teen-ager he had many hand-to-hand struggles with a vintage 1900 Heinel engine on the Anne B., a shad skiff used by the Barnard family during their summers at Bowers, Del. The engine, with its unorthodox lubrication system, was a challenge to young Barnard. Rod and wrist pin were lubricated by splash, while the crankcase contained salt water with the oil floating on the surface. Whenever the boat shipped water in a heavy sea, Dan had to bail out the crankcase, add more oil, and re-start the drowned engine. But Dan kept the Heinel running.

Barnard studied chemical engineering in the laboratory of Professor Charles L. Penny at the University of Delaware, where "precision, for the sheer sake of precision, was the rule." He survived this philosophy and was graduated with a BS in 1919.

Then he entered Massachusetts Institute of Technology and followed his dual interest in a thesis on the mechanism of lubrication. He was assigned to Dr. Robert E. Wilson, then director of the Research Laboratory of Applied Chemistry, for thesis supervision. This teaming of teacher and student resulted in several papers some of which, Barnard says, "every now and then pop up to haunt us" . . . and in a lifelong friendship. Barnard earned the degrees of master and doctor of science at M.I.T. and continued to work there in the Research Laboratory of Applied Chemistry for several years.

He was a divisional director of the laboratory when he left to join Standard of Indiana in 1925, again to work under Wilson, who had become Standard's associate director of research, and to continue his contributions to progress in improvement of the petroleum products required by automotive powerplants. He established the company's automotive engineering laboratory at the Whiting, Ind., refinery.

As a director of Coordinating Research Council since its incorporation and president in 1948, 1949, and 1950, Barnard has played an important part in molding and defining CRC policies, which have done so much to bring joint research and improvement by the oil and automotive industries.

One of Dan Barnard's few failures to achieve what he set out to do was his attempt to get into the flying end of World War I. He enlisted in the Naval Reserve early in 1917 and applied for aviation duty, but was not called up until shortly before the armistice the following year. "The nearest I got to sweeping the ocean clear of German submarines was manipulating a broom around the old Cape May barracks," he recalls ruefully.

The urge to fly stayed with him, however, and in 1934 he got his pilot's license and purchased second-hand an open two-seated Waco A plane which he flew for several years. "It was a lovely ship to fly," he remembers, "although taxiing on the ground required standing up in the cockpit to avoid overlooking such obstacles as hangars and the like, which could easily disappear beyond the big nose."

Barnard's interest in aviation is not limited to the Waco A. Since 1940 he has been a member of the subcommittee on fuels of the National Advisory Committee for Aeronautics, and during World War II was an aviation adviser to the Petroleum Administration for War, dividing his time between Washington and Chicago.

At his home in Dune Acres, Ind., Dan Barnard takes a busman's holiday by restoring ancient cars to running order. He is a member of the Veteran Motor Car Club of America and the proud owner of a single-cylinder 1906 Cadillac and a 1909 Model 10 Buick.

COUNCIL

E. F. Armstrong

Completing the 1951-52 term as councilors are E. F. Armstrong, General Motors of Canada, Ltd.; W. E. Beall, Boeing Airplane Co.; and R. F. Lybeck, Esso Standard Oil Co. (New England Division). B. B. Bachman, Autocar Co., serves again as treasurer. James C. Zeder, Chrysler Corp., and Dale Roeder, Ford Motor Co., continue on the Council as past-presidents. All vice-presidents representing Activities are members of the Council. Shown below are the three new councilors for 1952-53, Robert Cass, White Motor Co.; R. W. Goodale, Standard Oil Co. of Calif.; and Herb Rawdon, Beech Aircraft Corp.

Dale Roeder

W. E. Beall

R. F. Lybeck

B. B. Bachman

James C. Zeder

Robert Cass (M '39) has been assistant to the president of White Motor Co. since 1945, and is currently serving as deputy director of the Motor Vehicle Division of the National Production Authority in Washington.

He has been with White since 1925, when he joined the company as an engineer after a year as an engineering instructor at Harvard. In 1938 he was made assistant chief engineer, then chief engineer.

Cass was born in London and graduated from London University. He was a chief petty officer in the Royal Naval Air Service during World War I from 1915 until the Armistice was signed. He came to America in 1924 after five years with Short Brothers, British aircraft manufacturers.

Robert Cass

R. W. Goodale

R. W. Goodale (M '35) is manager of the Lubricant Division of Standard Oil Co. of California's Marketing Department. He joined the company as an engineer in the Producing Department right after his graduation from Oregon State College in 1929.

Three years later, he was transferred to the company's research organization as a fuels engineer at Richmond, Calif. From that time on, he has been increasingly active in fuels and lubricants projects—including SAE-API-sponsored desert tests, cold-weather field tests in northern United States and Canada, and Alaskan research on winterized petroleum products. From 1945 until 1947, when he received his present appointment, he had been assistant manager of the Product Acceptance Department.

Herb Rawdon (M '29) has been assistant chief engineer in charge of design at Beech Aircraft Corp. since 1940.

He got his BS in mechanical engineering from Tri State College in 1925, and his ME from Tri State in 1944. He has worked continuously in the aircraft industry since 1926, for such companies as Travel Air Mfg., Curtiss-Wright, Boeing, Lockheed, Aircraft Industries, Spartan Aircraft, and Douglas. His titles during this period included draftsman, stress analyst, design engineer, plant manager, and instructor in airplane design (at Curtiss-Wright Technical Institute).

Rawdon was chairman of SAE Wichita Section in 1944-45, and has presented several SAE papers.

Herb Rawdon

VICE-PRESIDENTS

A. W. Dallas — Vice-President, Air Transport

A. W. Dallas (M '31) has been director of engineering and maintenance for the Air Transport Association since 1943. His job involves assisting the scheduled airlines to solve their numerous technical problems brought about with the rapid growth of the industry after World War II.

He got his bachelor's degree in Aeronautical Engineering from the University of Detroit in 1929, and served as design and structural engineer in the aircraft manufacturing field until 1938, when he organized the CAA Fire Prevention Test Program at the National Bureau of Standards. The fundamentals of powerplant fire prevention which evolved from this program have resulted in operating procedures and design features widely used in modern transport aircraft.

D. Roy Shoults — Vice-President, Aircraft

D. Roy Shoults (M '47) is manager of General Electric Co.'s aircraft nuclear propulsion project. He rejoined the company last year, after a six-year absence during which he was successively vice-president of Bell Aircraft, vice-president of Glenn L. Martin Co., and director of engineering for ARO, Inc., managers and operators of the Arnold Engineering Development Center in Tullahoma, Tenn.

He entered the Test Engineering Course with General Electric in 1925, after his graduation from University of Idaho, and was later transferred to the Industrial Engineering Department. During World War II, he was in charge of application engineering of electrical and gas turbine apparatus for aircraft, including turbosuperchargers, aircraft gas turbines, electrical system equipment, and aircraft armament systems.

F. C. Mock — Vice-President, Aircraft Powerplant

F. C. Mock (M '11) is Director of Fuel Systems Engineering activity for Bendix Products Division of Bendix Aviation Corporation. He worked for various automobile companies from 1903 until 1911, when he went to work for the Stromberg Carburetor Co. in Chicago. During World War I, he was assigned to assist in Aircraft Carburetor Research at the U. S. Bureau of Standards Altitude Chamber Laboratory. In 1929, when Stromberg became part of Bendix, he went to the Eclipse Division of Bendix at East Orange, New Jersey, where he had charge of engine research and development of direct fuel injection. From 1935 until recently he was Manager of Fuel Feed Engineering at Bendix Products in South Bend, Indiana, where he was successively concerned with automobile and aircraft carburetors, direct injection for aircraft, gas turbine fuel controls, gas turbine fuel pumps, and components for guided missiles.

Mock is a past-chairman of SAE Chicago Section, has served on many SAE Activity Committees, and has delivered a number of papers before SAE National and Section meetings.

V. M. Exner — Vice-President, Body

V. M. Exner (M '47) has been with Chrysler Corp. as an automobile stylist for the past two years, and is now supervisor of Chrysler styling. For 12 years before joining Chrysler, he was in charge of styling for Studebaker Corp. Prior to this, he was a member of the styling staff of General Motors Corp., serving as supervisor of the Pontiac Studio.

His earliest professional work was done in illustration and layout for Advertising Artists, Inc., a South Bend firm he joined shortly after attending Notre Dame.

Exner has been an active participant in the SAE Body Activity for the past three years.

VICE-PRESIDENTS

W. G. Ainsley — Vice-President, Diesel Engine

W. G. Ainsley (M '29) is director of Sinclair Refining Co.'s engine laboratories, a position he has held since they were organized under his leadership in 1928. He also planned, built, and directs the engine laboratory operations of Sinclair's new research center in Harvey, Ill.

Ainsley graduated from Miami University, and worked first for Yellow Truck & Coach and as a high school physics teacher before joining Sinclair in 1926. He served overseas with the Motor Transport Corps in World War I, and in World War II was a consultant on fuels and lubricants in the Office of the Chief of Ordnance. He is now on the Research and Development Board of the Department of Defense as a member of the Lubricants Panel, Fuels and Lubricants Committee. He is active in CRC and ASTM as well as SAE; he was a member of the SAE Technical Board, and now heads CRC's Coordinating Lubricants and Equipment Research Committee.

V. A. Crosby — Vice-President, Engineering Materials

V. A. Crosby (M '44) has been metallurgical engineer at Climax Molybdenum Co. for the past 17 years—in charge of metallurgical development, sales, and service in the Detroit territory. He got his BS in chemical engineering from University of Mississippi, then served as a second lieutenant in the U. S. Air Force in World War I. He worked for Dodge Brothers, Packard, and Studebaker before joining Climax.

Crosby belongs to AIME, ASTM, AFS, ASM, and the Engineering Society of Detroit, in many of which he has held elective office. He has written many papers and has often lectured at various technical meetings on ferrous foundry techniques as applied to melting, alloying, and heat treatment. He received the John A. Penton Gold Medal of the American Foundrymen's Society last year.

J. G. Moxey, Jr. — Vice-President, Fuels & Lubricants

J. G. Moxey, Jr. (M '37) is assistant manager of Sun Oil Co.'s automotive laboratory. He joined the company's research and development department immediately after getting his BS in mechanical engineering from Swarthmore College. In 1940 he got the degree of mechanical engineer, also from Swarthmore.

Moxey has served on a number of SAE national committees, has contributed a number of technical papers, and was SAE Philadelphia Section chairman in 1946-47. Since 1939, he has been an active participant in CRC projects. During the war, he headed the Operation and Maintenance Group of CRC's Aviation Fuels Division, in addition to taking part in other phases of CRC work.

H. E. Churchill — Vice-President, Passenger Car

H. E. Churchill (M '41), director of research for Studebaker Corp., has been actively associated with the automobile industry since 1925. He attended Western State Teachers College and University of Michigan. After three years teaching mathematics and drawing, he became a draftsman for Dodge Brothers, working on chassis design. He has been a member of Studebaker's research department since 1926. In his present capacity he directs the testing and development of all parts of the passenger cars and trucks. He is also a member of the five-man operating committee which, under the direction of the vice-president in charge of engineering, is responsible for engineering policies of the corporation.

Churchill has served SAE Chicago Section as secretary, as vice-chairman for Passenger Car, and, in 1948-1949, as chairman.

VICE-PRESIDENTS

E. F. Gibian — Vice-President, Production

E. F. Gibian (M '28), chief industrial engineer for Thompson Products, Inc., was born in Czechoslovakia, where he got his mechanical engineering degree at the University of Prague. He worked abroad for two years as a design engineer, and after coming to this country spent 10 years with Jeffrey Mfg. Co. and Vlchek Tool Co. before joining Thompson in 1933. There he has been methods engineer, master mechanic, chief engineer of the Tapco Plant, and factory manager of the jet division. He assumed his present position in 1945.

Gibian has been active in the Production Activity Committee since 1946, and was its meetings chairman in 1950. He has been a panel member or a chairman at most of the SAE Production Forums in recent years, and has also presented many papers.

C. A. Hubert — Vice-President, Tractor & Farm Machinery

C. A. Hubert (M '28) is manager of engineering for International Harvester Co.'s farm tractor division. He has been with the company since 1937. With the divisional reorganization, he became chief engineer of the farm tractor division in 1944 and assumed his present position in 1946.

Hubert got his BS in mechanical engineering from the Polytechnic College of Engineering in Oakland, Calif., and in 1927 joined the Hall Scott Co. in Berkeley. Before his association with International Harvester, he was with Continental Motors Co. in Detroit.

He has served as chairman of the SAE Tractor Technical Committee.

Linn Edsall — Vice-President, Transportation & Maintenance

Linn Edsall (M '43) has been with Philadelphia Electric Co.'s Transportation Division all but one year since his graduation from the University of Pennsylvania. He has held various positions in this division and has been General Superintendent since early 1940.

He has served on the SAE Transportation and Maintenance Activity Committee for several years and was its Vice-Chairman for Meetings in 1951. He has been active in SAE Philadelphia Section and is now serving as its Chairman.

Edsall is a member and past-chairman of the Transportation Committee of the Edison Electric Institute, the Motor Vehicle Committee of the American Gas Association and Motor Transportation Committee of the Pennsylvania Electric Association.

F. W. Kateley — Vice-President, Truck & Bus

F. W. Kateley (M '24) is Vice President—Engineering of ACF-Brill Motors Co., Philadelphia. He received his BS in Mechanical Engineering from the University of Nebraska in 1920. His early experience after graduation was as a draftsman and designer with such truck and engine manufacturing companies as The Traffic Truck Co., Hinckley Motors Co., and Continental Motors Corp.

He joined the newly-formed ACF Motors Co., of Detroit, in 1926 as a designer on motor coaches. In 1928 he became chassis engineer and continued in this capacity until 1940, during which period the company's business was joined with The J. G. Brill Co., of Philadelphia. He later became motor coach engineer, and was made chief engineer in 1945. His present position began in 1951.

Kateley is registered as a Professional Engineer in Pennsylvania. He has been active for several years past on the SAE Truck and Bus Activity Committee.

President's Message

I wish every one of our 16,000 members could have shared the rich, satisfying and rewarding experiences which have been mine during the past year while serving as President of the SAE.

The wide scope of interest of our membership was better appreciated by attending the National Meetings of the 12 Professional Activities of our Society. The time and effort required for the success of such meetings both by the committees concerned and the various members of the permanent staff was better realized.

I have had the rare privilege of observing the "inner workings" of this great, live technical society, composed of many men, energetically and enthusiastically cooperating in all technical fields, and adequately served by a most competent permanent staff. I have seen our teams at work at all of our National Meetings and in many of our committees, Groups and Sections from coast to coast, including three meetings in Canada. Their friendly spirit and gracious hospitality cannot be forgotten.

On these teams are alert and enthusiastic men — men who are, perhaps, content with present accomplishments but who also are eager to do more to make our Society of even greater value. The spirit of cooperation by those who have served in the various offices and on committees was obvious. These men are generous with their time and in drawing from their experience to give advice and counsel to the younger officers and members.

The automotive industry has had to reduce civilian production due to curtailment of critical materials. Defense orders have been increasing, which has brought with them many problems. The SAE is again serving as an agency for the coordination with the military on these problems. The SAE and the industry which it serves are again performing a vital function in our American economy. The degree to which SAE serves is in direct proportion to the service rendered to the Society by its members.

The SAE is a great Society. To all of those who have shared in making it so, by serving so faithfully as committee members and workers throughout the Society, and to the members of the permanent staff, go my sincerest personal thanks for a job well done.

Dale Roeder

1951 Annual

ACTIVE participation in Society affairs by a large majority of members again marked SAE operations in 1951. Upwards of 2000 members served on national administrative and technical committees; over 1400 as Section officers and Section committeemen. Attendance at National Meetings alone totalled over 12,000, while Section meeting attendance was estimated at more than that figure.

Prospective members participated in SAE work more than ever before, as hundreds of nonmembers took part as panel members or were a part of sessions audiences at the two 1951 SAE Production Forums. These Production Forums, together with other panel and round-table sessions in 1951, not only had large audiences, but also served better the entire membership through Society publications. This wider value came from the work of appointed reporters—each an expert in his field. These reporters are now regularly being appointed by forum, panel, or round-table leaders from SAE members or guests.

The continued upswing in member participation in 1951 was reflected in healthy growth through every area of the Society's activity. SAE technical committees have been concerned increasingly during 1951 with the nation's rearmament job. Their work on critical materials is recognized as outstanding in meeting critical materials shortages. The Society's publications have expanded both the quantity and quality of the material brought to their readers. A new high of 15,393 for dues-paying membership was reached. The Society went over the million dollar mark in both income and expenditures. Its member service reserves now stand at about 90% of one year's expenditures. Eight new Student Branches were established—and the number of Enrolled Students declined only 600 (to 5249), despite military inroads on college enrollments in general.

Membership Total Reaches a New High

A new high for dues-paying membership was reached during the past fiscal year, which ended September 30 with 15,393 active members on the Society's rolls. The previous record was reached in 1947-48 when 14,810 members paid dues.

During 1950-51 new members and reinstatements totalled 1798 and membership losses were 1184, providing a net gain of 614. (Names of all those who

Report

qualified for membership during the year, together with the Section or Group into which they entered, were printed in SAE Journal each month.) The net gain for the previous year was 181, and in 1948-49 there was a net loss of 212 members.

Silver and gold membership cards for members who have paid their dues for more than 25 and 35 years, respectively, were sent out with the dues bills for the first time this year. This recognition of long-time members was voted by the Council at the recommendation of the Membership Committee Executive Committee. Twenty-five-year cards were mailed to 826 members, and 263 received 35-year cards.

Dale Roeder
1951 SAE President

Publication Work Stimulated in 1951

Publications in 1951 brought more news and engineering data to members from their SAE technical committees than in previous years. SAE Journal published full-length technical feature articles based on discussion at SAE round-table and panel meetings for the first time.

During the latter part of the year implementation began of a newly-stimulated program to (1) bring more oral discussion from meetings into publications, (2) improve the readability of meetings reports, and (3) print more nearly the maximum possible amount of material from technical committee activities.

A major decision made in 1951 was to publish SAE Transactions as a single bound volume beginning with 1953; to discontinue SAE Quarterly Transactions following publication of the four issues in 1952. Council approved this recommendation of the Publication Committee at its September 13 meeting.

A brief monograph was issued during the year describing fully the scope and importance of the work of the Readers Committees of the Publication Committee. (Copies of this monograph are available on request.)

SAE Journal

Some abridgment of every paper presented before the Society was printed in SAE Journal as in previous years. Of the abridgments, 123 were full-length feature articles. Reflecting the expanded scope of material available in several SAE areas, the total number of editorial pages in 1951 rose to 1029 as compared to the 980 of 1950.

SAE Quarterly Transactions

Of the 189 papers received at SAE Headquarters in 1951 following presentation at a National or Section meeting, 21% were approved by Readers Committees for publication. This compares with 20% of the 1950 papers; 19.8% of the 1949 papers; and 25.4% of the 1948 papers.

Quarterly Transactions carried a total of 583 pages of papers and discussions in 1951. This compared with 587 in 1950 and 680 in 1949. All papers approved by Readers Committees were published.

SAE Handbook

The 1951 SAE Handbook was the first SAE Handbook to appear in the new $8\frac{1}{2} \times 11$-in. size. It totalled 864 pages, as compared to the 1082 smaller-sized pages in 1950. With the larger page, the size of many illustrations was increased and the readability of tabular matter improved.

Production difficulties incident to the first complete re-setting of type and proofreading of all pages in a single year delayed publication until July.

Special Publications

Ten new Special Publications were issued during 1951. Important among them were SAE Reports on Boron Steels and SAE Truck Ability Prediction Procedure. Reprintings were made during the year

SAE Standing Committee Chairmen

S. W. Sparrow
Technical Board

T. B. Rendel
Publication Committee

O. A. Brouer
Membership Committee

C. M. Larson
Placement Committee

Merrill C. Horine
Public Relations Committee

of such popular Special Publications as SAE Automotive Drafting Standards, Automatic Transmissions Symposium, and several SAE Spring Reports.

The total number of copies of Special Publications distributed during the last fiscal year was 100,493—of which 52,775 were preprints of SAE meetings papers.

Public Relations

Public relations activities during 1951 continued to follow the conservatively successful pattern established by operations of recent years.

Releases were sent to newspapers and business papers preceding every National Meeting. Daily releases were made available to local newspaper men during each National Meeting.

Hundreds of questions were answered and information supplied during the year about SAE activities and operations. A more efficient procedure was used to make SAE papers readily available to outside publications for digesting and excerpting.

Public relations continues to aim primarily at creating favorable impressions about SAE among executives of the industries from which the Society draws its membership and among members and prospective members.

Meeting Attendance Soars to New Peak

A new all-time attendance record for SAE National Meetings was established during 1951 with more than 12,000 SAE members and guests registering for the 10 meetings held throughout the country. Six of these meetings—the New York Aeronautic, Summer, Tractor, Transportation, Fuels and Lubricants, and Diesel Engine—were the largest ever held. The number of technical papers presented—160—is 14% higher than in 1950.

Extension of Production Forums to two additional centers—Milwaukee and Los Angeles—contributed importantly to the new attendance mark. The Milwaukee Forum, held on September 10 preceding the National Tractor Meeting, was attended by 323 production engineers; and the Los Angeles Forum, held on October 3 before the National Aeronautic Meeting, was attended by 480.

Marked increase in the value of published reports from forums and round tables in 1951 resulted from the work of appointed reporters—each a specialist in his field—instead of staff reporters. These reporters are now regularly being appointed by the panel or round-table leaders from SAE members or guests.

The three engineering displays also enjoyed a banner year. Space at Detroit, New York, and Los Angeles was completely sold out.

For the second successive year, a Technical Air Review was held at New York International (Idlewild) Airport on the last day of the New York Aeronautic Meeting. The attendance of 600 at the 1951 Review testifies to the growing value and popularity of this event.

Attendance at the 1951 Summer Meeting was

limited only by the hotel accommodations. More than 100 SAE members had to be turned away for lack of accommodations. This is why the 1952 meeting will be moved to Atlantic City.

A unique arrangement of three National Meetings held within four days at adjoining hotels climaxed the 1951 SAE National Meeting season. All three of the meetings—the National Diesel Engine, Transportation, and Fuels and Lubricants—were the largest ever held, with registrations of 1156, 610, and 1200 respectively. This experiment demonstrated convincingly that such an arrangement helps all of the meetings, bringing to them a considerably greater attendance than would be possible if held separately.

Programs have been made larger and more attractive in appearance during 1951 through use of improved production methods. A change to first-class postage was made to insure faster and surer delivery to members. Projection of slides and motion pictures has been improved markedly during 1951 through the purchase of new and more efficient projection equipment.

Technical Committees Act in Rearmament Job

Once again in a national emergency both government and industry are looking to SAE technical committees for answers to urgent problems created by the defense program. As a result, during the past year the work of these committees has been concerned increasingly with the rearmament job.

The Society's work on critical materials is recognized to have been of outstanding value in meeting material shortages. Well before there was any real pinch on alloy steels, the SAE Iron & Steel Technical Committee was actively engaged in developing the possibilities of boron steels as substitutes for standard varieties requiring more critical alloys. The results of this work have been widely distributed and have accelerated the transition to these new alloy-conserving steels. Other critical metals and non-metallic materials have been the subject of intensive study from the conservation standpoint.

On military ground equipment, part by part studies have been made and substitutions recommended on a number of tactical vehicles and similar work on additional vehicles is in progress.

In the aeronautical field, new and revised Aeronautical Material Specifications have been issued in large numbers to keep this important series of specifications in step with the rapidly changing material situation. More than 900,000 of these AMS have been distributed in the past year which gives an indication of their utility and value.

A number of advisory technical reports on problems received from the Army were completed and transmitted in 1951. These included evaluations of automatic transmissions in tactical vehicles, winterization equipment and sealed brakes. Similar reports on other problems received from the Army are under development.

An extensive program of cooperation with the Air Force and the Navy Bureau of Aeronautics also has

SAE Standing Committee Chairmen

A. T. Colwell
Finance Committee

E. H. Kelley
Meetings Committee

Robert Insley
Sections Committee

W. A. Casler
Student Committee

C. H. Miller
Constitution Committee

been carried on. More than 100 military standards and specifications have been developed, revised or commented upon. These recommendations have been transmitted to the government through the Aircraft Industries Association. One of the most important of these recommendations covered a standard series of electric motors used in aircraft.

Another major activity in the aeronautical field has been on cockpit standardization. This has been of particular importance with the airlines exchanging airplanes to get maximum use. Recently a series of recommendations, covering the installation and functional requirements of controls for commercial airline cockpits, has been approved.

Despite the very large amount of work on defense program projects, the needs of civilian industry have received continued attention. Numerous standards and recommended practices for civilian equipment have been approved and issued. Among the items covered are grader and bulldozer blades, crawler tractor side-mounted booms, screw-thread gages, spark arresters, engine test procedure, radio noise suppressors, agricultural tractor wheels, hydrodynamic drive terminology, V-belts, carburetor flanges, fan bolt circles and pilot holes, fiber board, circuit breakers, and sound deadeners.

8 New Student Branches Installed

SAE welcomed eight new Student Branches during 1951 and renewed the charter for its original Student Branch, at Cornell University, which became inactive a few years after it was organized in 1915. These additions bring the number of active Student Branches to 42. The schools at which the new Branches were authorized are:

Carnegie Institute of Technology
Cal-Aero Technical Institute
University of Idaho
Michigan State College
Stevens Institute of Technology
Wayne University
University of Washington
University of Pittsburgh

At other schools SAE students have organized informal SAE Clubs preliminary to petitioning for Student Branch status. A Club must prove continuing interest in a campus SAE organization and secure endorsement of the school administration before its petition for a Student Branch Charter is considered.

Student Enrollment, affected by the overall drop in registrations at engineering schools, declined from the all-time high of 5848 in 1950 to 5249, as of September 30, this year. The growing number of SAE Student Branches and Clubs should strengthen the Student Enrollment of the Society even though there may be a continuing drop in the number of engineering students.

During the past fiscal year 455 SAE Enrolled Students applied for regular membership in the Society, accounting for approximately 22% of all applications received.

Sections Active Throughout All Areas

Pre-planning by Governing Boards of the Society's 36 Sections and 5 Groups made 1951 an outstanding year for SAE members in their respective areas. Besides sponsoring meetings covering practically every phase of automotive engineering, they arranged plant visits and social events for the local members. Governing Boards, functioning through their committees, also stimulated membership increase, SAE student activities, and use of the SAE Placement Service by individuals and companies in their areas.

A number of Sections were hosts to SAE National Meetings. These cooperated with the sponsoring Professional Activity Committees by arranging dinner programs and stimulating local attendance. The Central Illinois Section sponsored a two-day Earthmoving Conference which attracted members from coast to coast. An increasing number of Sections held meetings at different centers within their territories to benefit members located some distance from the headquarters cities.

It is estimated that more than 1400 members participated in Section and Group activities through membership on the Governing Boards and local committees.

Placement Service Faces New Outlook

Only a short time ago the Placement Committee was concentrating its efforts on expansion of its "Company List." Now, it cannot supply the demand for SAE members.

From this it is evident that conditions are excellent for the young man just out of college to canvass the field intelligently and get located in the very best position warranted by his capabilities.

Section Placement Chairmen, who have done such a magnificent job in making the Service what it is today, should by all means be consulted about job opportunities in their own areas.

Statistically, SAE has three times as many "Positions Available" and one-third fewer applicants than it had twelve months ago. In fact, slightly over 100 registrants are now available to fill the positions currently listed by the 558 companies that use the Service.

One company states: "Your cooperation in helping us to obtain the proper man for this position is sincerely appreciated." A member writes: "I appreciate very much the number of inquiries that my listing with your service brought and consider it a real indication of the industry's interest in SAE's placement service." A student writes: "The Placement service you offer the students is a very fine service. We have several organizations here at school and not one offers a comparable service."

The Placement Committee will continue to do its best to meet the requirements of an ever-changing economy.

Income and Expense

October 1, 1950 to September 30, 1951
In Agreement with Haskins & Sells Audit

Income

Membership		
Dues Earned	$256,135.74	
Subscriptions Earned	90,946.01	
Initiation Fees	26,543.75	
Miscellaneous Membership Income	1,180.12	$374,805.62
Publications		
Journal and Transactions Sales	41,059.04	
Journal Advertising-Less Agency Commissions	328,735.00	
Handbook Sales—1950	10,030.00	
Handbook Sales—1951	9,290.00	
Handbook Advertising	14,940.00	
Aeronautical Publications	87,052.64	
Special Publications	34,529.41	
Miscellaneous Publications Income	3,665.53	529,301.62
National Meetings		
Guest Registrations and Papers Sold at Meetings	7,599.83	
9 Dinners	33,645.46	
3 Displays	20,045.00	
Summer Meeting	9,357.00	70,647.29
Interest & Discount		
Interest Earned	16,250.90	
Discount Earned	1,556.74	17,807.64
Total Member Service Income		992,562.17
Industrial Income for Technical Board Services		186,456.00
Total Income		$1,179,018.17

Expenses

Sections and Membership		
Sections	$ 12,288.41	
Sections Appropriations & Dues	53,465.14	
Membership and Students	31,247.25	
Western Branch Office	16,853.92	
Miscellaneous Membership Expense	2,083.59	$115,938.31
Pro-Rated Administrative Expense (14.6%)		35,394.61
		151,332.92
Publications		
Journal and Transactions Text	135,054.69	
Journal Advertising	150,162.07	
Handbook Mailing—1950	472.26	
Handbook Text—1951	44,199.46	
Handbook Advertising	5,079.37	
Aeronautical Publications	25,839.99	
Special Publications	28,226.58	
Miscellaneous Publications	18,097.79	407,132.21
Pro-Rated Administrative Expense (51.1%)		123,881.14
		531,013.35
National Meetings		
Department Expense	37,270.15	
Cost of Registrations and Papers	5,926.66	
10 Meetings	34,747.82	
9 Dinners	29,751.13	
3 Displays	6,066.28	
3 Awards	790.17	114,552.21
Pro-Rated Administrative Expense (14.4%)		34,909.75
		149,461.96
Total Member Services Expense		$831,808.23
Technical Board Services		
Technical Committee Operations	$125,978.80	
CRC Appropriation	25,000.00	
Miscellaneous Expense	7,234.14	158,212.94
Pro-Rated Administrative Expense (19.9%)		48,243.34
		206,456.28
Total Direct Expenses	795,835.67	
Total Administrative Expenses	242,428.84	
Total Expenses		1,038,264.51
Added to Reserves		140,753.66
Total Income		$1,179,018.17

Membership Grading Committee Activities

The Membership Grading Committee reviews all applications for membership in the Society and for transfer of membership grade. From the information supplied by the candidates and their references, and from other data which may be available, it makes its recommendations to the Council, which takes final action on all applications.

During the 12-month period ending September 30, the committee reviewed 1840 new applications for membership and 299 applications for transfer or reconsideration of membership grade.

The Membership Grading Committee modernized the Society's application form and reference form

B. B. Bachman
Treasurer

with assistance from the Executive Committee of the Membership Committee. The new application was adopted by the Council and has been widely distributed to Section, Group and Activity Membership Chairmen. It includes data about the Society and its aims and activities, as well as information helpful to the applicants. The revised reference form has been in use since early in 1951.

Finances Keep Pace With SAE Activities

Treasurer's Report

The 1950-51 fiscal year saw SAE go over the million dollar mark in both income and expense. Net Unexpended Income was $140,000 and General Reserves reached an all-time high of $766,000.

It has been very salutary, in these times of increasing costs, that revenues have also increased. The principal sources of revenue for the past fiscal year were: Members' dues and fees at $373,000; advertising revenues at $343,000; publications sales $185,000. And these are all holding up well at current writing.

Financing of the Technical Committee Division has again been satisfactory. The Society provided $20,000 toward this and looked to industry to carry the lion's share. Industry responded generously, but the larger scope of the program necessitated the use of some of the Deferred Credit to Income which had been built up to protect this program against a rainy day.

The financial position of the Society appears sound and the future may well be viewed with confidence.

Finance Committee Report

Some years ago the Finance Committee, with Council approval, set a goal for General Reserves of one year's expenditures, exclusive of the Technical Committee Division which is largely financed by industry. Despite increasing costs, satisfactory strides have been taken toward that goal. Five years ago reserves represented 60% of this goal; today nearly 90%.

This means that, in the face of rising costs, the Society has successfully kept expenditures well within its income. Furthermore, the income picture has been good and currently shows no signs of reversal in trend.

With these factors in mind, the Council has specifically approved a budget which calls for greater expenditures in three important member service areas: Publications, with special reference to the Journal; Meetings, which provide the Journal's basic material; Sections and Membership, with an eye to broader staff contact with the Sections and Groups.

With respect to the Technical Committee Division, costs have gone up as demands for the work have increased. But industry has been generous in its support and there is reason to hope that this support will increase in 1952 to take care of the many projects that will make for simplification in industry's dealings with the military. In addition, the Finance Committee is eager to build a backlog for this work which will provide a stability comparable to the one being approached for the Member Service areas.

The new budget calls for an overall black figure of $69,000. This is believed realistic, but some more volatile sources of revenue, especially advertising income, may well vary the figure one way or the other.

In the meantime, the Finance Committee will follow the trend closely and recommend budget revisions to the Council during the year if such changes appear warranted.

Balance Sheet

As at September 30, 1951

In Agreement with Haskins & Sells Audit

Assets

Cash—Unrestricted	$ 188,497.53
Restricted	14,584.51
Notes & Accounts Receivable—Less Reserves	17,385.81
U.S. Gov't Bonds—Cost Value (Acquired during year—$75,460.94)	693,114.88*
Accrued Interest on Bonds	4,570.57
Inventories	1,160.09
Deposits	550.00
Furniture and Fixtures	1,000.00
Deferred Charges and Prepayments	85,860.57
Total Assets	$1,006,723.96

Liabilities and Reserves

Accounts Payable	$ 14,417.10
Section Dues Payable	4,254.00
Deferred Credits to Income:	
Member Dues Received in Advance	95,182.25
Industrial Income for Technical Board Services	63,980.55
Subscriptions	19,230.19
Others	15,118.09
Reserves for Unexpended Contributions	9,385.10
Reserve for Retirement Plan Contributions	18,463.08
General Reserve	766,693.60
Total Liabilities and Reserves	$1,006,723.96

* Book Value—(Quoted Market or Redemption Value at 9/30/51—$668,271.27).

Gas Turbine Truck—Part I

Turbine Wheel Problems

EXCERPTS FROM PAPER BY

Henry C. Hill, Boeing Airplane Co.

• Paper, "Progress of Gas Turbine Truck Tests," was presented at SAE National Transportation Meeting, Chicago, Oct. 29, 1951.

TWO earlier articles[1,2] have told SAE readers about the 175-hp gas turbine developed by Boeing and installed in a Kenworth truck. This truck has now been in operation for over a year, during which period it accumulated 15,000 miles in 550 hr of driving, mostly with a tractor-trailer load of 68,000 lb.

Presented here is the author's discussion of the difficulties that have been experienced with the turbine wheel during the tests, and what sort of developments have been made to overcome these troubles.

The original paper also gives an extensive report on other phases of the test program, such as engine operating characteristics, engine noise and cooling, fuel and oil consumption, and problems encountered with other turbine components. The author's report (along with pertinent discussion) on these matters will be briefed in Part II of this article, which will appear in next month's issue of the Journal.

Although many difficulties have been encountered and fuel consumption is not yet what it might be, the development work is still young, and the author believes that competitive turbine engines are not far off—availability for commercial use depending, to a large extent, on the military situation.

THE heart of a turbine engine, as perhaps should be obvious, is the turbine wheel. That is to say, the day-to-day operating reliability and useful service life are pretty much a matter of dependability of the turbine wheel and its blades. We say this with some assurance because it is based on a year's experience with the truck, and on 4000 hr of test stand running. Many other troubles have been encountered but cured without great difficulty, whereas in spite of continuous improvement in turbine wheel life, some part of this unit continues to remain as the determinant of ultimate engine life.

This is somewhat of a mechanical paradox because in all existing industrial experience there is no simpler or more reliable mechanism than a spinning disc, which, after all, is what the turbine wheel is. But the spinning disc with blades attached becomes an extremely complicated design problem when subjected at the rim to a high-velocity gas stream at 1400 or 1500 F temperature.

Fig. 1 shows the Boeing engine first-stage turbine wheel, and Fig. 2 the second-stage wheel. Each of these wheels had 563 engine running hours. Figs. 3, 4, 5, and 6 show four of the five distinctly different types of failure experienced at various periods in the development of this engine.

The first major difficulty on the test stand and in the early truck runs was with wheel rubs—that is, rubbing contact between the turbine blade tips and the surrounding shroud. This was caused, not by growth of the wheels, but by distortion of the shrouds. It is no longer a problem, but a lot of work was required to isolate the cause and to determine the optimum blade tip clearance, as well as to develop a nozzle shroud not subject to growth or

[1] See SAE Journal, Vol. 58, November, 1950, pp. 52-54: "More Payload for Same GVW Possible with Truck Turbines," by W. M. Brown.
[2] See SAE Journal, Vol. 59, October, 1951, pp. 24-25: "Latest Facts about Turbine-Driven Trucks," by R. C. Norrie.

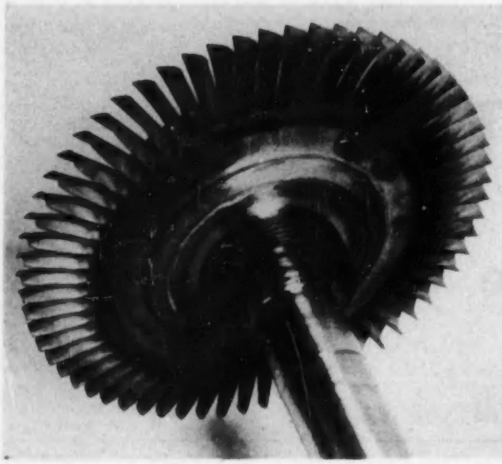


Fig. 1—First-stage turbine wheel—after 563 hr of endurance running

Fig. 2—Second-stage turbine wheel—after 563 hr endurance. This wheel and rest of engine successfully completed standard Navy diesel engine proof test

Fig. 3—Impact damage of turbine blade leading edge from a foreign object in gas stream

out-of-round distortion from repeated heating and cooling. In a turbine with small wheels this is apt to be critical because, to avoid serious gas leakage losses, the tip clearances need to be in the neighborhood of 0.015 in. This is not a lot of running clearance considering the speed of 36,000 rpm and the temperature range of - 65 F to 1500 F.

The second type of turbine wheel trouble, illustrated in Fig. 3, was blade damage and cracking as a result of foreign objects passing through the

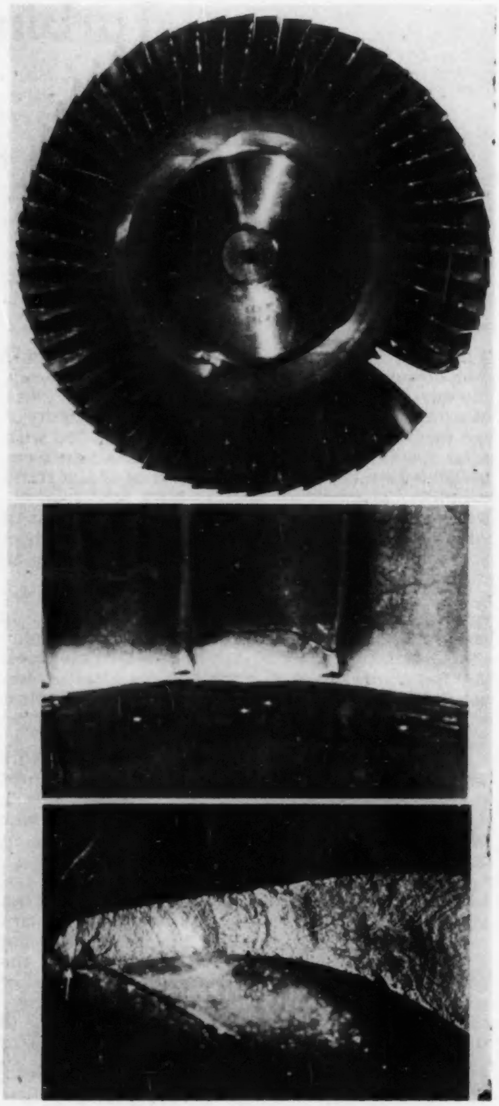


Fig. 4—Photographs of typical blade fatigue failure

blades with the gas stream. In early test stand work these objects were usually small pieces of burner liner, spark-plug electrodes, or corners broken off compressor elbow vanes. These fragment failures were the result of structural weaknesses, augmented by high-frequency vibration, and were corrected by detail design improvements. The nicked nozzle vanes and turbine blades were usually repairable by careful smoothing with a small grinding wheel, but it was found important that the small impact cracks be ground out and the work checked by Zyglo inspection. This, again, is no longer a major problem, and the hazard from small pieces of metal entering the compressor inlet does not appear to be any more serious than the corresponding hazard of foreign matter entering the carburetor inlet of a piston engine.

Vibration

Failures of the second-stage turbine blades in the airfoil section were the next most serious difficulty. This type of failure, illustrated in Figs. 4 and 5, has never occurred in the first-stage wheel, and this fortunate circumstance helped provide the clues for the remedy.

The source of the trouble was resonant blade vibration or, rather, two resonant vibrations, one of which was the fundamental bending mode causing fatigue fracture near the blade root, and the other a corner flapping mode at higher frequency, which caused the trailing edge corners at the tip to break off. These failures were stopped by successive steps of stiffening the blades with relatively slight changes in profile and radial section—thus raising the natural frequency as well as reducing the centrifugal stress. With the present type of blades we have not had any of these failures in the past six months, in spite of some very severe operating conditions.

We think this may be significant in establishing a relation to steam turbine practice, where, as is well known, very high standards of reliability are

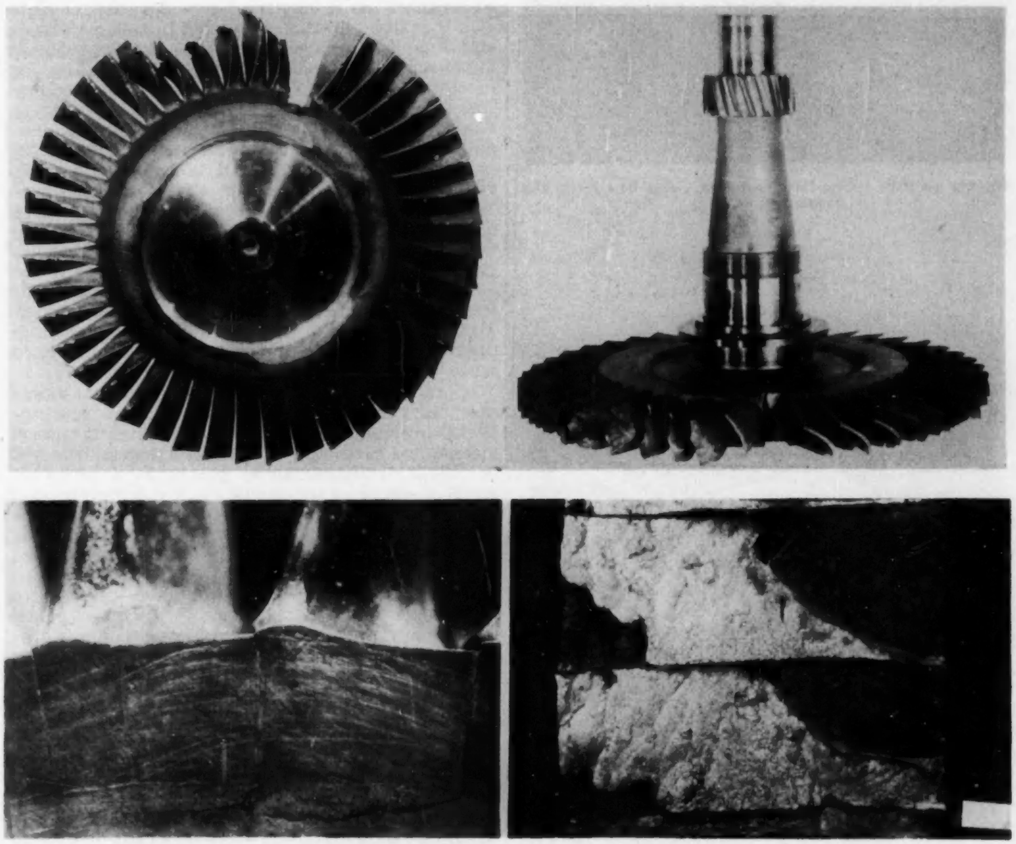


Fig. 5—Second-stage turbine blade weld failures

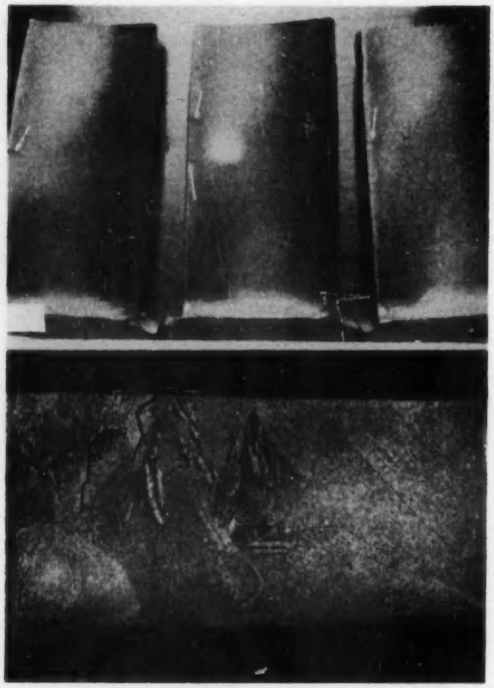


Fig. 6—First-stage turbine blade heat-shock cracks from acceleration temperature overshoot

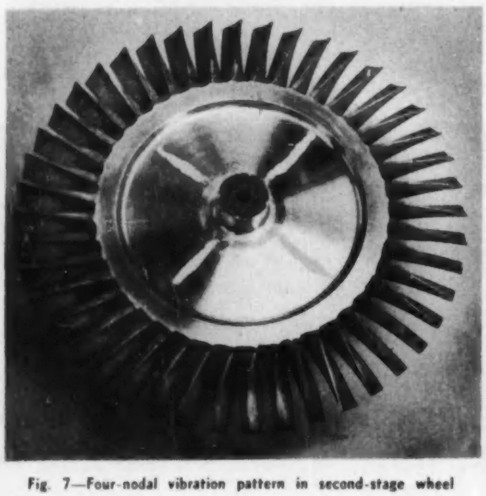


Fig. 7—Four-nodal vibration pattern in second-stage wheel

commonplace. In steam turbines, according to engineering literature, it is necessary in order to avoid fatigue failures to design the blade natural frequencies to be above the sixth order of the rotor speed—that is, the blade must not respond in resonance to any vibration frequency, in cycles per second, below six times the wheel speed, in revolutions per second. With the Boeing turbine we had to get above the ninth order, which is 3700 cps, a fact no doubt associated with the presence of stronger sources of the higher order frequencies in the compressors, burners, and high-speed gearing of the shaft drive gas turbine.

The blade root fracture or weld failure, as we call it, is shown in Fig. 5. This has been, until quite recently, the most serious and most stubborn difficulty limiting the life of the second-stage turbine wheel. At the time of this writing, it is too early to say we have completely licked this one, but current results so indicate.

Again the chief source of trouble was vibration, this time in the disc of the turbine wheel. This is rather an astonishing thing in view of the thick, small-diameter chunk of metal that forms this wheel disc. As a matter of fact, all existing data said that disc vibration as known in steam turbines and large gas turbines could not be present with the dimensions and speeds involved in the small Boeing machine. Nevertheless we have readily produced "on the bench," with excitations of very small energy, resonant vibration of the 4, 6, and 8 nodal patterns, also in some cases the single-node circular pattern. Fig. 7 shows the 4 nodal pattern made visible by sprinkling salt on the vibrating wheel. This is the pattern that is easiest to excite, and the one which had the lowest natural frequency in the wheels which failed (3200 cps). Fig. 8 is a photograph of the equipment developed at Boeing to excite and measure blade and disc vibration, showing the phonograph type of pickup and amplifiers. This work is done in a specially constructed soundproofed chamber to muffle the intense high-pitch noise which accompanies these vibration tests.

It probably will be a surprise to many that vibration plays such an important part in a machine that is inherently smooth and in very nearly perfect mechanical balance. This is, nevertheless, true and is vividly demonstrated by balancing a pencil on any flat portion of the engine while running through the full range of power and speed and at the same time observing the sensitive electrical vibration instruments. The oscilloscope will trace out responses from pickups on any exterior surface of the engine, to an almost unlimited number of frequencies and their harmonics, but the pencil will remain unaffected. This is because the vibrations are in the very-high-frequency low-amplitude range; in fact those that cause vibration resonance in turbine blades and discs are so high in frequency as to be above the accurate range of available vibration pickups.

To add to the complexity of this problem, both the high speed and the high temperature of the running wheel have marked effects on the natural frequencies of the blades and disc, as well as on the damping factors of the materials, which determine the degree of response to resonant vibrations.

We have recently found also that the method of machining the wheels after welding of the blades on the wheel rim has an important effect on the stress levels at the welded joint, which in turn influence the vibration characteristics.

Fortunately, the solution to this confusing array of complicated variables appears again to be rather simple—namely, to steer the design and fabrication so as to produce wheels that will consistently have vibration responses above the range of the critical exciting frequencies of the engine. This is indicated in the vibration spectrum plot of Fig. 9.

Excessive Thermal Stress

The blade crack shown in Fig. 6 is a distinctly different type of failure, not associated with vibration, but caused by excessive thermal stress known as "heat shock." This showed up in the early running of the test truck and was traced to transient excessive combustion temperatures caused by momentarily too high a fuel rate during fast accelerations. In simpler terms, the driver's footwork on the accelerator pedal was a bit too fast, and we were fooled by the fact that ordinary exhaust stack thermocouples were too slow to pick up the transient overheating. The remedy was, first, the development of fast-acting thermocouples and, second, accurate adjustment of the acceleration limiting device in the fuel governor system to reduce the maximum acceleration fuel rate until the temperature overshoot stayed within safe limits. This increased the idle to full-throttle accelerating time from 3 to 5 sec but the effect as far as handling the truck on the road was not noticeable. We believe this bit of research was of considerable significance in establishing the fact that engine acceleration suitable for road vehicle use can be provided and safely controlled in the small gas turbine.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Fig. 8—Apparatus developed at Boeing for checking blade and disc natural frequencies

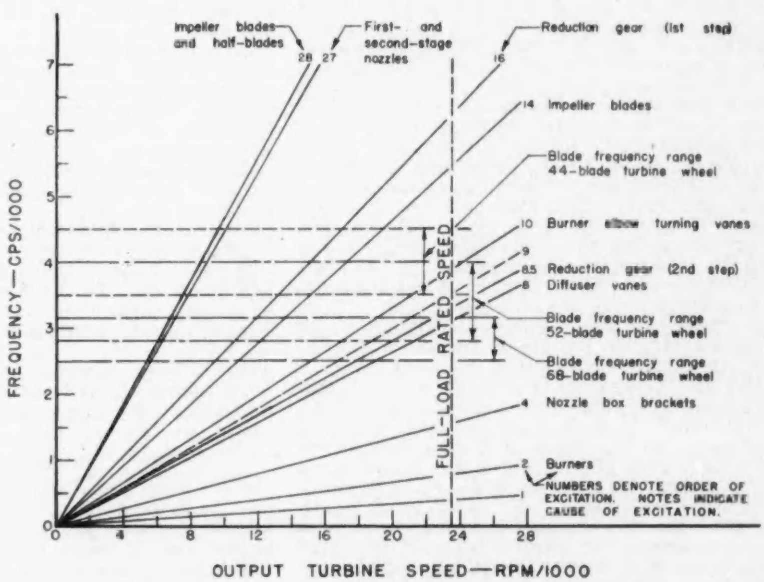


Fig. 9—Vibration spectrum plot for second-stage turbine blades

Benson Ford

"It's the Engineer's

I THINK we're going to have to re-examine our products in the light of changing conditions and changing needs. And, as we look for answers to our problems, it will be the engineer's turn at bat again.

I'd like to suggest that one of the most important areas of opportunity for the automotive engineer is in materials—especially metals. Most engineers would agree that we could use a new type of basic metal which is stronger, lighter and cheaper to produce than steel. Insofar as automobile manufacturing is concerned, the advantages of steel are offset by a great many disadvantages and, in time, those disadvantages could force us to find something better. If the weight of a car could be reduced by a third, for example, there would be large savings to both the manufacturer and the customer. And perhaps, with another metal, there could be mechanical improvements which are not possible now.

I've been told that the use of aluminum is not entirely an answer, because of the cost of fabrication. But is that the extent of the possibilities?

And must we continue to rely upon materials that are almost always scarce and are likely to be scarce in the future? In most of our cars, there is 40 to 50 lb of copper, a metal which has been in short supply for a long time. During World War II, there was barely enough for wartime needs and practically none for ordinary civilian use. It was never plentiful after the war—mainly, I realize, because of pent-up demand for products using copper—and today it has again become in critically short supply.

Engineers and scientists have been searching for copper substitutes for a long time, I am told. But it seems to me that we in the automobile industry cannot rely entirely upon long range efforts in this direction. We have no assurance that, even after the current and expected needs of the armed forces have been met, we will be able to obtain enough copper to satisfy our production requirements. If we are to overcome this recurring problem, we must learn as quickly as possible to substitute satisfactorily for copper and other critical materials.

What are the possibilities of plastics or glass? Have we done as much as we can in the area of synthetics? Under present circumstances, we cannot afford to overlook even the slightest possibility in this area.

I am sure the public would not arbitrarily insist on our building cars with a certain amount of copper or zinc or any other scarce metals. Their concern is with performance, not with how we achieve performance. In fact, there might come a time when we would all have to get along with what are now regarded as substitutes. It certainly doesn't seem too soon to be taking practical steps to meet the possibility.

Another area which will undoubtedly grow rapidly in importance—especially if important sources of raw material should be denied us for a long period of time—is fuel. We know that the world supply of oil is not inexhaustible. And we know, too, that if Russian aggression should extend still farther without bringing on total war, we might not be able to obtain sufficient oil for our national needs—or might have to pay sucn exorbitant prices that it would not be worth it. It's easy to see what that would mean to us.

Atomic Power?

Fortunately, there are several other possibilities opening up to us—possibilities which I'm sure you've already begun to measure in terms of automotive power. One, of course, is atomic power; another is solar power. I have no idea as to how either of these giants could be harnessed to the type of automotive vehicle we're familiar with today.

Turn at Bat Again!"

EXCERPTS FROM PAPER BY

Benson Ford, Vice-President, Ford Motor Co., and General Manager, Lincoln-Mercury Division

• Paper, "Engineering for Tomorrow," was presented at SAE Detroit Section Meeting, Dearborn, Mich., Oct. 1, 1951.

But I do know that a start has been made on atomic-powered submarines and aircraft. And apparently there is enough assurance of success to warrant limited production. Offhand, it isn't hard to imagine what might be done with a smaller automotive power unit and less expensive operation—with a smaller power unit, we might be able to design a roomy car that would still help solve the country's parking problem.

Engineers have already looked into the possibilities of the diesel and of jet propulsion. Perhaps they're impractical or too costly now, but can they be modified in any way to suit our purposes? (There's an advantage in not being an engineer, in that you can ask questions like that and not have to wrestle with the problem yourself.)

And, while we're looking into the future, let's talk about traffic safety. In a way, this is a problem for automotive engineers, too.

Just about as many Americans have been killed by automobiles in the past 51 years as have been killed in all of our wars during the past 176 years.

That's a very sobering set of figures. But, more than that, it's a pretty horrible indictment of our ability as a people to handle the speed and power which have been built into our industry's products. Obviously we can't control the men and women behind the wheel. Human nature being what it is, some people would get into trouble riding baby buggies.

But have we exhausted all the possibilities of providing maximum safety for the users of our products? The modern car has a long list of safeguards which, under normal conditions and with proper driving habits, should protect its occupants fully—four-wheel brakes, bumpers, safety glass, windshield wipers, rear-view mirrors and many others.

But I think we might go even farther. In this age of radar and electronics, it seems to me that there might be ways of protecting even the poorest driver against himself and of cutting down the heavy traffic toll. Would it be possible, for instance, to attach an electronic control in such a way that, when a collision is imminent, the brakes would be applied automatically? I understand that some railroads have adopted this principle and are able automatically to prevent train collisions within certain controlled areas of track.

Driver Warning Devices

Can we devise some means of warning a driver—possibly through a flashing light on the dashboard—when there's a car approaching the other side of a curve? Is it possible to work out a device that would automatically dim an approaching car's high beams if the driver didn't do so?

That sort of thing could be carried to extremes, I realize. Someone might also expect us to work out some sort of gimmick that would automatically steer a car into the nearest gas station when the tank gets close to empty.

But where safety is involved, I think we should give more than ordinary consideration to any new idea which may have practical application. We in the industry have an obvious stake in helping to make our highways as accident-free as possible.

These are admittedly tremendous tasks which I have suggested for the engineer. Some may be worthy of your efforts; some may not. But I think that, in general, they are areas which will claim more and more of your attention as time goes on. One immediate question which comes to mind is that of cost. It's an element the engineer must always consider. But I'm sure we can all think of improvements which were ridiculously expensive when they were first considered but are now well within reason and pretty much taken for granted.

In addition to the problems we can foresee now, there will inevitably be new and more difficult problems which will demand all the resourcefulness and ingenuity at our egineer's command. It will be up to the engineer to lead the way.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

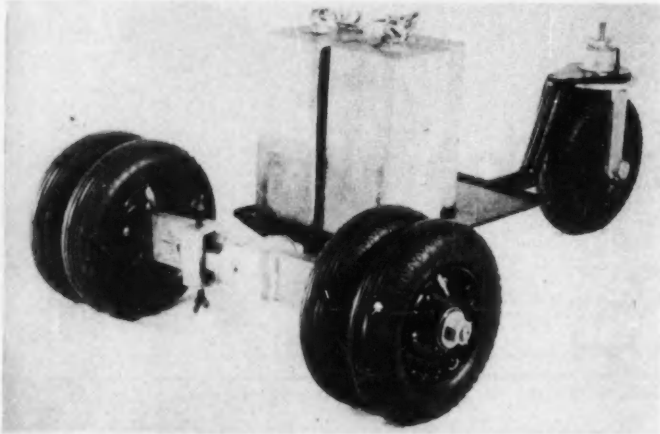


Fig. 1—Test cart used to demonstrate the forces which act on dual tires to cause the outer tire to wear to a smaller diameter than the inner one

Why

"MATCHING" may be considered to be the selection of two tires for use as dual mates which have dimensional characteristics promoting an equal distribution of load between them. In simple terms this means to match together tires of equal diameters, assuming that axles are straight and that roads are flat.

At this point, the practical details intrude. On operations of moderate size one can almost never find two tires with the same diameter—except in the case of new tires of identical size, make, and type. Now, since there is a difference in diameter, a decision must be made as to where the larger tire should be placed. A second decision should also be made, namely, what is the greatest diameter difference permissible.

Matching of dual tires is commonly accepted as selecting two tires of as near equal diameters as possible (no more than $\frac{1}{4}$ in. difference) and placing them together as duals with the tire of larger diameter on the outside position.

But most people who are associated with trucks in service have seen outside dual tires on driving axles wear smooth earlier than their mates on inside positions. This is most likely to be noticed on the original driving tires on a new truck, and the occurrence is the rule rather than the exception. Thus a situation has developed by itself which is exactly contrary to the "matching" recommended by the tire industry.

For the purpose of demonstrating the forces which act on dual tires a small cart was built which had a tricycle arrangement. (See Fig. 1.) The dual rear wheels are mounted on plain bronze bearings and normally are free to turn independently, although they can be locked together. The tires are singe tube pneumatics, size 8×2.00, and are inflated to 10 psi for demonstration. They are nearly identical in diameter, varying from each other by only one or two sixty-fourths of an inch. The load is three iron weights totalling about 75 lb.

The rear axle is pivoted in the center and can be deflected upward or downward by means of thumb screws. The amount of deflection is indicated by the pointer on a scale marked in degrees. Moving the pointer one degree space on the scale moves each set of dual tires one degree with respect to the vertical.

So much for the vehicle. The roadway used for most of the demonstration is 2 ft wide and 6 ft long (long enough to allow for two revolutions of the rear wheels). It looks flat but actually has quite a high crown. The curvature is such that it requires 1 deg of camber in each set of duals on the cart to make the duals stand perpendicular to the road surface.

Let us consider first the case of driving axles because these axles are made straight.

The cart is placed on a flat surface. The axle is straight (set at zero degrees). Tires are the same diameter and all are inflated to the same pressure. Here we have the ideal condition insofar as tires are concerned. After lining up the transverse white lines on the tire treads the cart is rolled two revolutions of the rear tires. The white lines remain together although the wheels are free to turn independently. The full significance of this will not be recognized until after the next phase of the demonstration.

Now we shall change just one variable, the road surface, and put the cart on the crowned track. Two revolutions of the rear wheels now move the lines on the inside duals noticeably further than the lines on the outer tires. (See Fig. 2.)

Right here is the reason why dual tires do not stay matched. The diagram in Fig. 2 shows road crown

Dual Tires Do Not Stay Matched

EXCERPTS FROM PAPER BY

H. M. Place, U. S. Rubber Co

• Paper, "Why Dual Tires Do Not Stay Matched," was presented at the SAE National West Coast Meeting, Seattle, on Aug. 15, 1951. (This paper will be printed in full in SAE Quarterly Transactions.)

causing the inner tire to deflect more than the outer one, which results is a slightly shorter rolling radius on the inside tire. This difference in rolling radius results in a different amount of rotation in each wheel, causing the inner tire to turn further than its mate.

Now suppose that instead of two independently rotating wheels, they were rigidly bolted together as is true on most trucks and trailers. Obviously, two such wheels would have to rotate together, but the inner tire would still be trying to turn at a slightly higher rate than the outside tire. The force thus developed causes a "fight" between the inner and outer tires. And it is a continuous fight as long as the tires roll on crowned roads—which is virtually all the time. This "fight" is relieved by slippage; slippage of tire on pavement.

Referring again to the diagram in Fig. 2, it is readily apparent that the inner tires are more heavily loaded. Since the outer tires have less load, they are the ones which do the slipping, and this wears them down quite rapidly as compared to the inner duals. However, once a certain differential in diameter is established, the two tires wear at fairly equal rates. The differential in diameter will vary from one run to another, one vehicle to another, and even from end to end of a given axle. Diameter differentials in worn tires are usually fairly small, being less than $\frac{1}{4}$ in. where the "average" road is fairly flat. But certain cases have been observed where diameter differentials of dual tires have been as high as $\frac{5}{8}$ in. due to much high-crowned macadam road.

Fortunately, for tread life, there is another factor which enters into the diameter relationship of dual tire mates. This is "growth". Tire cords stretch slightly under the constant pull created by the inflation pressures. And, since it flexes more, the inside tire grows more than its mate on the outside position. This extra growth on the inside tire reduces the amount of wear on the outside tire needed to achieve the diameter differential normal to that particular operational unit.

Fig. 3 shows how the "fight" between the duals is diminished as the outside tire diameter is worn down. This suggests that, if the outside tire becomes enough smaller than the inner tire, the "fight" will disappear altogether. However, only

A GOOD program of dual tire matching on one operation may not give as good results, relatively, on another. Hence, it is impossible to make one blanket recommendation which will give the best overall results on all fleet operations.

However, with a better understanding of what takes place on his operation, an operator can develop his own rules for prolonging tire life.

This paper points out the forces which act on dual tires to cause the outer tire to wear to a smaller diameter than the inner one. It is not to be construed, however, as recommending any particular service procedure or type of vehicle equipment.

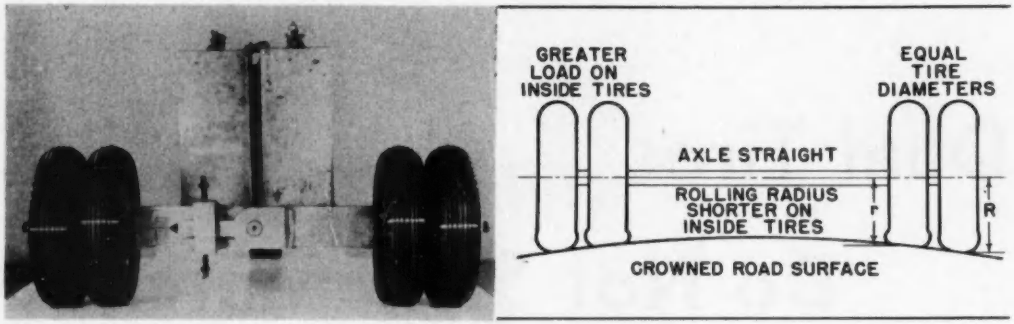


Fig. 2—Road crown causes the inner dual tire to deflect more than the outer one. Resulting difference in rolling radii produces a "fight" between duals which are rigidly bolted together

where tire mileages are high does such equilibrium occur. On operations where lower tire mileages prevail, the outer tires become smooth before the diameters become stabilized. The indication that dual tires tend to stabilize at a diameter difference normal to the prevailing operating condition is strengthened by the fact that it is possible to manipulate the camber of the demonstrator axle so the dual tires turn at the same rate. This is the case whether the tires are of the same diameter or not.

These two facts indicate that: (1) there are certain combinations of axle camber, tire diameter, and road crown where there is no "fight", and (2) when two tires mounted in dual run over the same route repeatedly under uniform conditions of load, inflation, driver habit, and so forth, they tend to conform to a diameter relationship determined by those operating conditions.

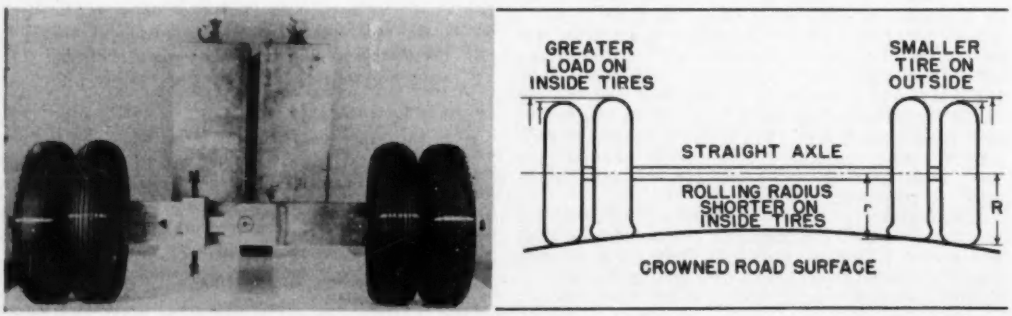
Left to themselves, then, dual tires generally wear to a combined profile which is the opposite of what is recommended for equal load distribution.

At this point one of two things happens. Either the tires are left as they are, or they are changed. In the writer's opinion, the majority of dual tires are allowed to run at whatever diameter relationship is natural to them until some other reason, such as a puncture, necessitates a change. However, there are operators who, in their efforts to give their tires proper treatment, require that dual tires be measured periodically. And, when the outside tire is found to be smaller than the inside, changes are made to re-match the tires. Sometimes the inner and outer tires are simply interchanged. In other cases, more complex manipulation is used. The case where the inner and outer tires are interchanged is simply a reversal of the diameter relationship of the two tires, and, as such, lends itself to this demonstration.

The larger inner tires are now interchanged with the smaller, more worn, outer tires. When this change is completed the larger tires are on the outside, in other words, they now conform qualitatively to the definition of matching given earlier. Two revolutions of the wheels now produce the greatest amount of "fight" yet.

This large amount of "fight" results in very rapid wear on the outside tires. A loss of about ⅛ in. of tread depth on such an outside tire in 3000 miles of running has been observed, where, at the same time, the inner tire was hardly wearing. Such a tread loss is the exception and not the rule. But it does illustrate the point that rubber comes off the outside tire rapidly when the outside tire is larger than its

Fig. 3—The "fight" between duals is diminished as the outside tire diameter becomes smaller



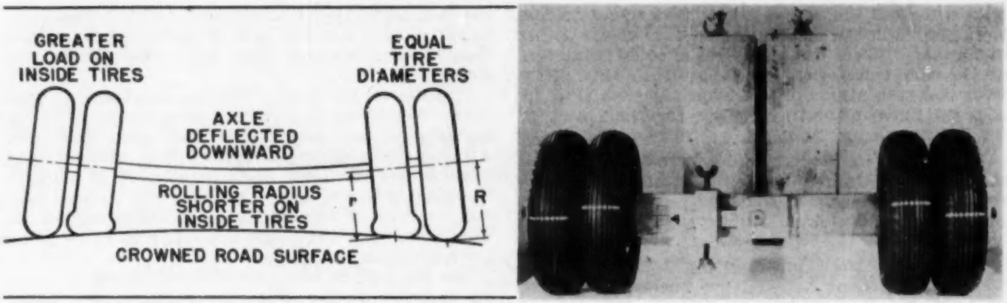


Fig. 4—Downward deflection of the axle increases the effect produced by road crown, causing greater "fight"

mate. The result of this—and this is important—is that the outer tire will again end up with a smaller diameter than its mate on the inside wheel.

Switching duals, then, results in faster tread wear (as well as relieving the inner tire of excess load), making the job of keeping the load distributed equally between dual driving tires endless.

However, the effects of the higher load on the inside tire resulting from the larger diameter of that tire are not causing undue tire troubles, as far as we can see. But it is possible that such running of dual tires may result in a failure of the inside tire after it is recapped, especially if it is returned to an inside drive wheel after capping. Limited evidence on a severely high crowned road tends to bear this out. Here is a place where operators with tire records can use them to learn how much tire life, if any, is lost from running on inside positions. Relatively little is known on this subject, but it has direct bearing on tire costs.

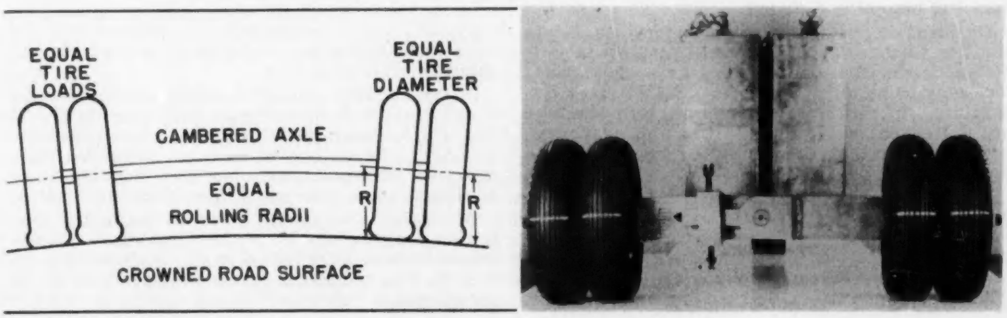
Up to this point the discussion has been confined to the effects of road crown. Now let's look at the effects of axle conditions.

Downward deflections of the axle increases the effect produced by road crown. Any axle load produces a downward deflection of some magnitude, and, of course, the heavier the load the greater the deflection. Most of these axle deflections are temporary, existing only while load is present. However, overloading of the axle can produce a permanent deflection, or sag, in it. Axle deflections measured by the writer have all been of the temporary type and have been small (¼ deg or less). An axle deflection of ¼ deg on the demonstrator will produce a noticeable change in the position of the lines on tires of the same diameter and with the same inflation pressure. But such change is small, so, for the benefit of the demonstration, the condition will be exaggerated to 1 deg of negative camber in the axle. After two revolutions of the wheels, we have a much greater space between the lines on the tires than when the axle was straight. Fig. 4 gives an idea of the kind of "fight" which would occur between the dual tires on a "sprung" axle. Compare this with the effect in Fig. 2.

Now let us turn from driving tires to those on trailers. One significant difference between driving tires and trailer tires is that trailer axles are cambered in recognition of the fact that roads are crowned and that axles deflect. Since a trailer axle is much simpler than a drive axle, it is not especially difficult engineeringwise to put camber in it. The question is, how much camber?

It was stated earlier that 1 deg of camber in the

Fig. 5—A cambered axle can, under ideal conditions, counteract the effect of road crown



dual wheels of the demonstrator cart would set the tires perpendicular to the road surface at the points of contact. Therefore, with tires of equal diameters on the cart, 1 deg of camber is set in the axle. Now with two revolutions of the wheels we see (Fig. 5) that the lines on the tires remain together, in other words, there is no "fight" between them.

We see in Fig. 5 what trailer manufacturers are striving for. Unfortunately, the trailer manufacturer can only guess at the road crown over which his product will operate and try to hit an average condition.

Referring to the diagram in Fig. 5, it is seen that we have, in effect, restored the ideal between the axle and the road surface, so that the tires roll on equal radii. Thus, there is no "fight", and the tires are equally loaded. The tires will retain their equal diameters and so divide the load equally throughout their lives as dual mates. This, again, is an ideal situation.

It is possible to put more camber in an axle than is required. Another degree of camber will be set in the axle. This might be called a "one degree" track; again there is a "fight" or rotational difference between the dual mates. This time, however, it is the outside tire which turns the furthest because the rolling radius of the outside tire is now smaller than that of the inside tire. In other words, the situation has become reversed from what it was on the drive axle.

The author has not had the opportunity to study trailer dual tires extensively. However, from investigating a few complaints of irregular wear on trailer tires, the opinion has been formed that some trailer axles have more camber than necessary for the general average of roads over which they operate. These observations have been complicated by the fact that the operations observed operated fully loaded in only one direction, which may have meant that camber was too high when the vehicle was empty.

Another factor enters into the operation of dual tires. Reference is made to manipulation of inflation pressures between inner and outer dual tires. A great many operators inflate both duals to the same pressure. Some use 5 or even 10 lb more in the outside tire to force the outer tire to pick up a larger share of the load than it otherwise would. Then there are some who are reported to be using more pressure in the inner tire.

The demonstrator indicates that the use of more air pressure in the inner tire reduces the "fight" between the duals and that higher pressure in the outside tire increases the "fight". Increasing the pressure of either dual tire reduces the deflection of both. However, the increased pressure causes the tire which contains it to assume more of the load shared by the two tires. We have already seen that the inner tire assumes a higher load than the outer tire because of: (1) road crown, (2) axle deflection, and (3) the fact that the outer tire wears to a smaller diameter. Now if we add more load to it by increasing its inflation, we are adding to a situation which is already working toward shorter carcass life. For this reason it does not seem advisable to use higher inflation on the inner tire, although a few cases have been reported where such an increase in air pressure has reduced irregular wear on the inner tires. This is another place where operators can learn something useful both to themselves and the transportation industry.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Excerpts from Discussion

By Hoy Stevens

American Trucking Associations, Inc.

Mr. Place has presented a clear and interesting explanation of a phenomenon with which truck and bus operators have contended for years. However, his explanation does not indicate criteria by which truck operators may judge the correctness of their dual tire matching program.

He mentions that it is of prime importance to save the tire casing. This is the real problem in long distance, over-the-road combinations where loadings may be as much as 125 to 135% of rated tire capacity. In this type of operation, heat blowouts are a frequent cause of flat tires and, of course, with heat blowouts the casing is damaged beyond repair.

If an operator does not suffer from heat blowouts he may have no problem. If he does, even if only in hot weather, he can judge the correctness of his tire mating practices by review of the tire position of blown tires. When blowouts are equally distributed between inside and outside dual tires, his matching is the best so far as casing life is concerned. If tire blowouts are not evenly distributed between inside and outside tires, matching or inflation should be adjusted.

A quicker check on matching, which can be used during experimentation to develop correct matching standards, is to check tire air pressures at the start and end of a run. To start such a test tires should have the same air pressure (or a fixed difference in pressure) and be at the same temperature. Tire temperature will be reasonably stabilized if the tires are allowed to cool and stand for at least 2 hr before gaging and starting runs.

At the end of a run, or at intermediate points on a long run, the dual tires again should be gaged. If the air pressure in both tires is still equal (or with the fixed difference) it may be concluded that matching is satisfactory, since both tires will have developed equal amounts of heat from tire flexing.

Of course, test runs must be such that brake heat is not a factor in the air pressure readings. That is especially true with regard to city bus operation or runs on long mountain grades which require much use of brakes.

Shot Peening

Deserves Consideration During Initial Design

BASED ON PAPERS BY

Earl H. Abbe
Springfield Armory

Thomas Backus
Fuller Mfg. Co.

John C. Straub
American Wheelabrator & Equipment Co.

• Papers "Ordnance Applications of Shot Peening" by Abbe, "Shot Peening of Heavy-Duty Transmission Gearing" by Backus, and "Shot Peening in the Design of Machine Parts" by Straub were presented at a meeting of Division XX—Shot Peening of the SAE Iron and Steel Technical Committee, Sept. 21, 1951, at Hot Springs, Va.

DESIGNING new machine parts from the start to be shot peened could result in better products in many cases and reduce production expense in other cases.

Shot peening increases the stress allowable in parts subject to alternating loads. With a given material, the benefits can be taken in the form of (1) increased fatigue life or (2) smaller-size parts saving material, labor, and weight in the finished product. Or lower-strength materials can be used for a given size of part.

Proof of the contention that shot peening improves fatigue life advanced by J. C. Straub and Thomas Backus came in two examples of shot peening to avert design changes cited by Earl H. Abbe.

The Springfield Armory shot peened the friction bar for a drop hammer for 2 min with No. 12 shot at 100 psi pressure to an intensity of 0.030C. This treatment so improved the 7-ft long by 1¾-in. diameter WD1020 steel friction bar that it was still operating satisfactorily two months later when the forge was shut down. Previous bars had failed in fatigue after 2 to 30 days of use and averaged only 10 days.

More spectacular improvement resulted from shot peening of extractors for M-1 rifles. Fatigue failures were prevalent at a fillet. Changing the design was out of question, so metallurgists tried shot peening. No change was made from the WD8745 steel oil quenched and tempered to Rockwell C40-43. But a lot of 6000 extractors was peened with shot 0.014-0.020 in. in diameter at 60 psi air pressure from 5/16-in. nozzles 3 in. from the fillet. A sample group from this lot was fired to failure in endurance weapons. Minimum life (average life of the lowest tenth) of the peened extractors was 5266 firings as against 1448 for extractors not peened. Average life for the entire peened sample was 8677 as against 4020 for extractors not peened.

Now all extractors for the M-1 rifle are peened, Abbe said.

Backus cited numerous instances where shot peening has improved fatigue life of gears. He also mentioned another way that Fuller Manufacturing uses shot peening to save material. They shot peen the inner diameter of some gears instead of tin plating or using a bushing. The shot-peened surface provides sufficient oil adherence to maintain a film between the shaft and the gear.

Shot peening has been so useful in correcting design inadequacies and in strengthening parts to take greater loads imposed by new uses, that it has been used almost exclusively for those purposes. Straub and Backus both feel that shot peening might aid in accommodating substitute materials, particularly boron steels, without redesign of parts. Backus questions, in regard to boron steels, "Can shot peening do for resistance to shock what boron does for hardenability?"

But there's no question, Straub and Backus feel, that shot peening deserves consideration in initial design of new parts.

Straub pointed out the benefits that might ensue from designing a coil spring to be shot peened as compared with a spring to do the same job without being shot peened. On the assumption that shot peening would increase allowable stress 10%, weight would be decreased at least 10%, due to the smaller wire diameter useable. (The weight saved due to

(Continued on Page 46)

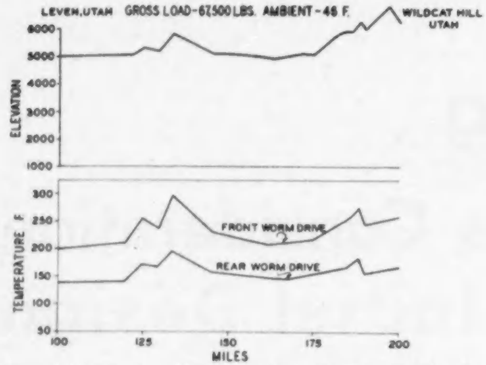


Fig. 1—Oil temperature of one rear axle was found to lead the other by more than 100 F

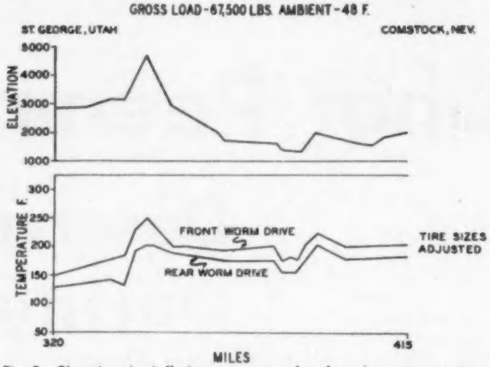


Fig. 2—Changing tire inflation pressures reduced maximum temperatures on grades by 50 F

Tire Matching Reduces

UNEVEN tire wear or tire mismatching affects lubricant performance and maintenance cost of dual drive worm gears.

In the early use of heavy-duty trucks equipped with this type of final drive, little attention was paid to tire wear and matching. However, when operators repeatedly put good equipment on the road, followed best maintenance practices, used finest lubricants obtainable—and still had unexplainable premature failures—they solicited the aid of technical men to look elsewhere for the trouble. Many tests and studies were made, but the importance of tire matching of the driver wheels provided the most interesting data toward a solution.

Data Prove Importance of Tire Matching

Let's review some of the data that called our attention to the importance of tire matching.

Rear axle temperatures in Fig. 1 were recorded during a test conducted primarily for the purpose of obtaining crankcase oil and other engine operating temperatures. For this reason, matching of tires, alignment, and adjustment of the rear axles were not checked by the test engineers. However, because the oil temperature of one rear axle constantly led the other by more than 100 F, inflation pressures of some of the tires were changed. Maximum temperatures were reduced by 50 F on grades (see Fig. 2), even though the grades were steeper after changing the tire pressures.

However, matching of tires by adjusting inflation pressures is highly controversial. Some fleet operators inflate all-drive axle tires to the same pressure, some inflate the inside dual tire less than the outside one, and still others adjust the loaded radius by varying air pressures only.

Due to these differences of opinion, the results of three tests (shown in Fig. 3) are of interest. These tests were run on level road and the loaded radius of the tires was obtained by varying only inflation pressure. No attention was given to such tire conditions as tread, balance, and so forth. Notice that after 30 min of operation with tires

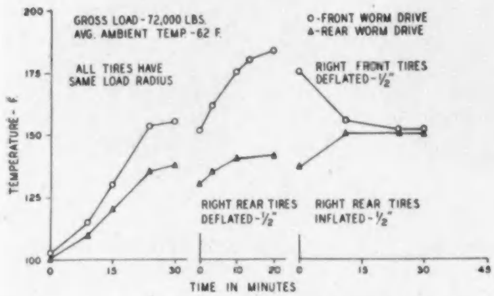


Fig. 3—Varying the loaded radii of the driver tires has a marked effect on axle lubricant temperature

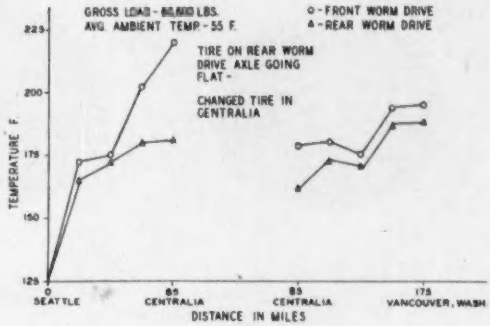


Fig. 4—Lubricant temperature rises as the tire on a rear axle gradually goes flat

Final Drive Failures

EXCERPTS FROM PAPER BY

J. R. Schmitt, Standard Oil Co. of Calif.

• Paper, "Effect of Tire Mismatching on Lubricant Performance and Maintenance Cost of Worm Final Drives," was presented at SAE National West Coast Meeting, Seattle, on Aug. 15, 1951.

having the same load radius, the oil temperature of the forward rear axle exceeded that of the rear rear axle by approximately 25 F. Reducing the rolling radius of the right rear tires ½ in. further aggravated this condition. After only 20 min, the front axle led the rear axle in temperature by approximately 55 F. Increasing the rolling radius of the right rear driver tires ½ in. and decreasing the right front driver tires ½ in. materially reduced (in 30 min) the oil temperature of the forward rear axle. This also brought the oil temperatures of both rear axles very close together. However, most manufacturers of tires and rear axles do not recommend adjusting inflation pressures of tires of greatly varying conditions to obtain more than ⅛ in. plus or minus load radius.

Fig. 4 shows the results of a tire going flat. Temperature rise is gradual due to the progressive loss of tractive ability of the rear unit. The tire was not changed when it was first noticed that it was going flat—only road speed was reduced. Rear axle wheel bearings are a part of the rear axle mechanism and each bearing is designed to carry only its portion of the load. With one tire flat, the entire load must be borne by one bearing which can result in an early fatigue failure.

A typical example of the effect of continuous tire mismatching on the gear lubricant in a rear axle after only 12,000 miles of service is shown in Fig. 5. Laboratory tests showed the condition of the oil in the forward axle (except for color) to be comparable to new oil, and that excessive temperatures in the rear rear axle caused the oil to coke and the worm wheel to fail. Fig. 6 shows an example of such failure.

To prevent such failures and increase worm drive mileages between overhaul, many operators are becoming tire-and-rear-axle preventive maintenance minded and are constantly striving to improve their technique. In many cases where tires were checked for mismatch once a month or every 10,000 or 15,000 miles, this inspection now takes place every 2000 or 3000 miles. Where rear axles were only checked when abnormal noise or trouble was

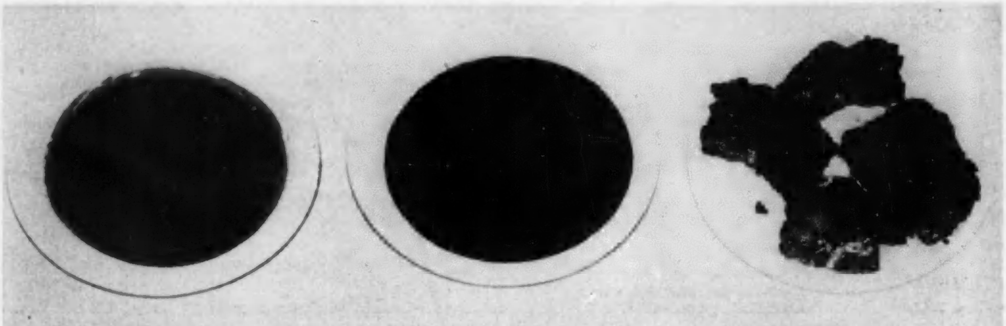


Fig. 5—Continuous tire mismatching caused the lubricant in one rear axle to coke after only 12,000 miles of service

Fig. 6—Typical gear failure in heavy-duty service resulting from continuous tire mismatching

indicated, they are now inspected at specified intervals—and when abnormal conditions are found they are corrected.

Best operation will result, of course, if all the driver tires are the same circumference and have treads in the same condition of wear. Except on new units this is not only very expensive but impractical as well.

A compromise and accepted practice is to use dual tires on the left side of the front rear axle which have the same circumference and tread as the dual tires of the left-rear rear axle. On the right front install dual tires that have the same circumference and tread as the right rear.

The circumference of the tires on the left do not have to be exactly the same as those on the right because the differential gears will compensate in traction on the straightaway just as they do on a curve. However, continuous operation of the differential is undesirable.

Can the mechanic, tire man, or serviceman follow out this procedure? Yes, he can, in several ways.

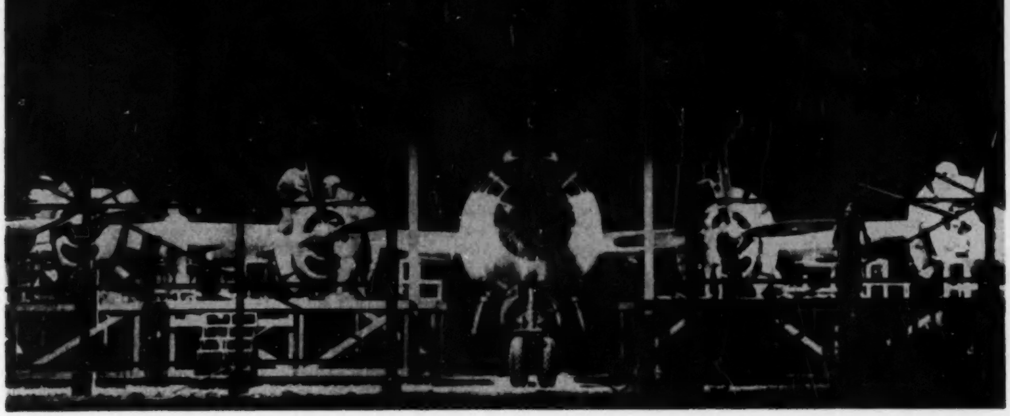
The use of tire calipers has been tried, but does not secure good results except on new tires. Used tires from heavy-duty service often contain flat spots from braking; therefore, it is impossible to take diameter measurements within the allowable tolerances of $\frac{1}{4}$ to $\frac{3}{8}$ in. In many cases a steel tape is used to measure the circumference of the tires before they are installed, and the tires are marked and kept in reserve according to size. Some fleet truck drivers are equipped with flexible measuring devices so they can check and match tires when a spare is installed.

A popular practice for a periodic check when tires are already on the vehicle is to measure the rolling circumference. This can be carried out on the shop floor or service ramp. Each tire, and the floor where the tire is in contact, is marked with a piece of chalk. The truck is then moved through three tire revolutions. If the travel of the front driver tire varies from the rear by more than 2 in., the tires are mismatched. And they should be checked individually and matched according to equal circumference as in the original installation.

However, even the finest equipment—under the best maintenance practices—won't give best results unless the driver personnel lend their support. They, too, should be instructed in tire-matching practices and be provided with spare tires to fit the units being driven.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Aircraft Maintenance in Korea



EXCERPTS FROM PAPER BY

Col. T. J. Noon, Aircraft, Fleet Marine Force, Pacific

• Paper "Aircraft Maintenance in Korea," was presented at the SAE National Aeronautic Meeting, Los Angeles, on Oct. 6, 1951.

AIRCRAFT maintenance methods being used in the Japan-Korea area depend largely on the fortunes of war and on military tactical requirements.

The Inchon-Seoul campaign involved the capture of a beach-head, securing the airfield, and continuing the assault to the objective—the capital city of Seoul. The landing and capture of the beach-head proceeded according to schedule. Within three days Kimpo Airfield was captured and tactical squadrons, standing by at our rear base, moved in and commenced close air support.

However, difficulties were encountered in unloading shipping in Inchon Harbor, and there was a serious delay in getting gear to the airfield. We had foreseen this possibility and had made previous arrangements to be prepared to deliver POL, ammunition, miscellaneous gear, and personnel via air transport to Kimpo Airfield. But the service squadron was delayed in getting their heavy gear ashore and to the field. This situation necessitated a quick change in plans.

Service squadron shops were immediately set up in operation at our rear base. Aircraft spares, communications, and motor vehicle spares were set up on a quick ready for issue status. Aircraft based at Kimpo which were either shot up or damaged were repaired by personnel using hand tools. Mostly, this involved a complete change of component parts. Defective parts were airlifted to our rear base for repair, then placed back in the ready for issue stock.

The Wonsan landing was quite similar to the Inchon landing, but one additional problem was encountered in the Wonsan area—cold temperature. Maintenance problems became more severe and minor defects more frequent. It became necessary to exercise greater control over the work performed both in the forward and rear area.

It also became necessary to anticipate the aircraft which would create trouble and fly them to the rear base before they became lame ducks. Those aircraft requiring engine change, major checks, and the communications trouble makers were flown to the rear for repair. Nevertheless, the lame ducks were increasing—due chiefly to battle damage. (This was during the time when the Chinese Communists intervened.)

Service squadron facilities in the forward area had to be increased. In view of the probable withdrawal from the Wonsan-Yong-Po area it was desired to keep the size and weight of the service squadron equipment down to a minimum. Only the smaller

and lighter pieces of machinery were airlifted in. However, it was sufficient to keep the aircraft in a flyable status.

The availability of suitable airfields in Korea from which to operate was extremely limited. Also the fast moving situation and the desirability of having the aircraft based close to the front lines ruled out any plan to establish a large repair base in Korea.

We reduced our squadrons down to the minimum bare necessities to operate and packed these so they were all capable of being airlifted. Refuelers and large communication vans were about the only pieces of equipment that could not be airlifted. The balance of the gear was established at Itami, Japan where—by the time the evacuation from Hungnam had been completed—service shops were in full operation. Aircraft were rotated from the operating squadrons through the shops at Itami on a time basis. This system materially assisted in keeping more aircraft available over a long period of time and under all kinds of operating conditions.

To be capable of meeting workload demands of tactical units, service squadron aircraft shops were established on regular production line methods. A repair line was set up in a hangar and this line was supported by various feeder shops located in the hangar leanto. (Due to the large workload in the electronic, communication and salvage shops, separate buildings were used for this work.) Close control was maintained over the workload assignment in both the feeder shops and the repair line. An attempt was made to arrive at workload forecasting as far in advance as possible. Daily reports were maintained showing actual work completed, and the on-hand backlog—with an estimated completed date. Assignment and scheduling of the workload necessitated frequent contacts with all units in the field and was very much a full time job.

It can be readily seen that the part which the rear area service squadron played was an extremely important one. They were responsible for effecting repairs on damaged aircraft, vehicles and equipment —and for maintaining a ready-for-issue pool of (1) aircraft, (2) vehicles, (3) spare parts, and (4) communications and electronic equipment.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Shot Peening Deserves Consideration During Initial Design

Continued from Page 37

the decrease in wire length to obtain the desired spring rate is neglected.)

Based on the production schedule and production cost figures of one large spring manufacturer, the 10% reduction in material represents a \$25-per-hr saving after peening costs are paid, if spring steel costs only 5¢ per lb. Figured on the less conservative, more realistic basis of a 20% weight saving and 7½¢ steel, the saving would be around \$80 per hr.

In initial design of gears, shot peening might indirectly relieve scoring problems, Straub explained. The scoring tendency of gears is strongly influenced by tooth height. Shorter teeth favor scoring resistance. So a fine pitch, due to its shorter teeth, favors scoring resistance. But fine pitch is accompanied by thin teeth having relatively low bending strength. Shot peening could improve bending strength so that thin teeth would be useable—and thereby shot peening would contribute to scoring resistance.

Designers might find it worth while to investigate the answers to these three questions propounded by Straub:

• What are the possibilities of precision casting and shot peening parts instead of following the usual sequence of machining and heat-treating? Eliminating the heat-treating would avoid distortion.

• How much larger would a pair of machined and shot peened cast-iron gears have to be than gears forged, normalized, machined, carburized, hardened, and tempered and possibly ground to eliminate the distortion due to heat-treatment?

It is unlikely that gears of ordinary cast iron could take the place of carburized gears without appreciable increase in size and weight. But there might be cases where the cost of production might decrease in spite of the extra material because of lowered labor costs.

• Where cast iron is impractical, what are the possibilities of using nodular iron and shot peening it? According to reports, tensile strength of nodular iron is well over 100,000 psi, and yield point as high as 90,000 psi. Compressive strength of nodular iron is said to be much greater than tensile. If it is true that the higher the compressive stress, the higher the residual compressive stresses a material absorbs from peening, then nodular iron ought to be a good material for which to design gears.

Flight Experience with First Turboprop Airliner

EXCERPTS FROM PAPER BY

G. R. Edwards, Vickers-Armstrongs, Ltd.

• Paper, "Flight Experience with the Vickers 'Viscount' Turbo-Propeller Airliner," was presented at the SAE National Aeronautic Meeting, Los Angeles, on Oct. 6, 1951. (This paper will appear in full in SAE Quarterly Transactions.)

WHEN the Viscount 630 made its initial test flight on July 16, 1948, it became the first civil turboprop aircraft in the world to fly. Since that date, this aircraft has gained the first full British Certificate of Airworthiness enabling a turboprop engined aircraft to carry fare-paying passengers.

Initial Flight Trials

Early handling trials showed that the airplane was pleasant to fly. (This initial impression has subsequently been confirmed by the many airline pilots who have handled the 630.)

The handling trials enabled a full evaluation to be made of the engine/propeller combination characteristics. It was found that the original ground fine pitch setting was too coarse, with the result that too much thrust was developed when the engines were idling on the ground. The re-adjustment of this setting to 0 deg satisfactorily overcame this undesirable feature.

During the latter stages of these flight trials, criticism was made about the rate of power increase during balked landing overshoot procedure. At that time, the approach rpm were 6000, the propeller blades therefore being in a relatively coarse pitch due to the low propeller rpm. Upon opening the throttles, the interconnected throttle/propeller controls had the effect of moving the blades into finer pitch due to the automatic selection of higher rpm. This finer pitch caused a momentary loss of thrust, resulting in deceleration, which was then very quickly changed into acceleration as the pitch increased to absorb the increasing engine power.

It was decided that this characteristic had to be eliminated so that the response rate would be equal to, or better than, that obtainable from a piston engine. This was achieved by increasing the approach idling rpm to 10,000, with the result that the approach blade angle was much finer and an increase of power could be applied without any appreciable thrust loss. Immediately after touchdown, the flight-fine pitch stops are withdrawn. The "discing" effect of the propellers rotating at a higher speed has the additional advantage of increasing the drag to some 4,000 lb at 85 mph, and decreasing the landing run, the rpm at this stage being about 8000 instead of the previous 6000.

A further improvement was achieved by fitting throttle-operated electrical micro switches into the landing flap circuit. Flaps are automatically lowered from an intermediate position to the "full down" when the throttles are closed, and are similarly raised if the throttles are subsequently reopened due to overshoot action.

De-Icing Tests

During January and February, 1950, the 630 was operated out of Shannon airfield for the purpose of proving the airframe thermal de-icing system. This system consists of ducts, formed by double skinning along the airfoil leading edges, through which hot gases—bled from the jet pipes—are passed. (Heat exchangers are used on later aircraft.)

Flights were made at altitudes varying between 4500 and 15,000 ft in temperatures between 0 and -25 C. Considerable ice build up (up to 6 in.) was obtained with the icing system inoperative. The

handling qualities of the aircraft remained satisfactory, and when the system was switched on, the worst ice accretion was broken up in about 4 min without any serious signs of run-back. When entering icing conditions with the system on, heavy build up was experienced on aerial masts, and so forth, but the main surfaces remained satisfactorily clear. As a result of these tests, the Air Registration Board cleared the airframe for flights in icing conditions, and the power plants for "light icing" conditions.

European Tours Undertaken

Throughout March and April, 1950, two extensive European continental tours were undertaken. The first covered Central and Southern Europe, while the second included the Scandinavian and Low Countries. These tours were of special interest because they were undertaken jointly with British European Airways. Valuable airline experience was thus obtained.

Airline techniques were employed as far as possible, both as regards crew drill and aircraft handling. Cockpit lists and drill cards were prepared in accordance with airline practice.

The best climbing speed was found to be 156 knots E.A.S. at 13,600 rpm at which a climb rate of 1700 fpm gradually reducing to 500 fpm at cruising altitudes of 20,000 to 23,000 ft was achieved.

The cruising rpm were varied between 13,000 and 13,500, the aircraft being maintained at constant rpm and I.A.S., and allowed to climb gradually as the weight decreased. This technique was considered to give a suitable compromise between economy and simplicity of control.

After checking several let-down procedures, it was finally agreed that a 2-engine let-down procedure at about 210 knots would be entirely practicable.

Extracts from the B.E.A. report on these flights record that "the remarkable serviceability given by the engines" and the "ease of airframe maintenance" were outstanding features. The only work necessary on the engines, apart from routine maintenance, was the replacement of one torch igniter.

Engine routine maintenance times have been reduced to an absolute minimum—a power plant can be changed in 35 min; a starter motor in 15 min; and a feathering pump in 30 min. A turbine examination can be completed in as little as 10 min.

Tropical Tests

Early in June, 1950, the 630 was flown to the British Ministry of Supply's Tropical Testing Unit at Khartoum, and later to Nairobi to check the takeoff performance. These tests entailed 70 flying hours, including transit times. One hundred takeoffs were carried out, water methanol injection being used 80 times. The maximum ambient temperature experienced was 45 C at Khartoum and 20 C at Nairobi where the airdrome altitude is 5300 ft.

As a result of the satisfactory conclusion of these trials, a full passenger carrying Certificate of Airworthiness was granted on July 26, 1950. Immediate advantage was taken of this Certificate. The Viscount 630 was put into passenger operation by B.E.A. on July 28, 1950, for a test period of four weeks. The object of this was two-fold: (1) to enable B.E.A. flight and handling crews to obtain advance experience with turboprop aircraft, and (2) for both B.E.A. and Vickers-Armstrongs to obtain valuable data concerning the economical operation of this type of aircraft over routes, and into airfields, being used simultaneously by piston engined machines.

The routes chosen by B.E.A. were London to Paris and London to Edinburgh. Normally these services are operated by 27-seater Vickers Vikings. The Viscount seating was reduced to 27 and it thus became completely interchangeable with a Viking so far as passenger capacity was concerned. Other modifications were removal of the rear toilet to provide additional freight space, and completion of the forward toilet water system. In this condition, the aircraft offered a disposable load of 12,031 lb, the all up weight being 42,500 lb.

The first London to Paris flight, with 14 passengers, was made on July 29. Outward time was 57 min and return time 65 min. The first London to Edinburgh flight was made on Aug. 1, the outward journey taking 1 hr 51 min, the return journey from Renfrew (Glasgow) to London consuming 1 hr. 50 min. The fuel used on both these flights amounted to just over 460 gal.

Subsequently, 36 round trips were made to Paris and 8 return flights to Edinburgh—some in very bad weather, with continuous cloud top to 20,000 ft (the highest level at which the aircraft was operated). Fare-paying passengers carried on the Paris route were 1493, and 322 passengers were carried to and from Edinburgh.

An analysis of the passenger "comment cards" showed that reactions to turbine-engined aircraft were completely favorable. Many expressed enthusiasm for this mode of comfortable, quiet and vibration-free travel.

The series of flights indicated to B.E.A. that performance variations, due to differences between the skill and concentration of individual pilots, are likely to be greater than those experienced with piston-engined aircraft. The method of presenting performance data to the pilot is therefore a matter of great importance. It is thought that a command pilot's conversion course to turbines would only take 12 to 15 hr, including night flying.

Air traffic controllers did not experience any difficulty in handling the Viscount in the piston-engine-aircraft control pattern, once the higher operating altitudes and let-down speeds were appreciated.

Throughout the whole period of Viscount development, the airplane and engine achieved a very high standard of serviceability. During the B.E.A. operation, the schedule maintenance man-hours amounted to only 0.44 per flying hour. The total man-hours expended on unscheduled maintenance amounted to 6¼, making a total of 0.48 per flying hour for all maintenance.

The development flying and operational experience, gained with the Viscount 630, have shown conclusively that the production version will be a markedly simple aircraft to maintain and that the engines will give safe and reliable service. The easy maintenance of the engines has surpassed the manufacturers' early predictions.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

IN this article, based on a paper by J. A. Edgar, the use of high-additive oils in engines employed in city, long-haul, and off-the-road service is described.

In his original paper, the author also discusses the processes responsible for engine and oil deterioration. He shows that the wear problem is really one of corrosion rather than abrasion or cutting away of the metal surface. He notes that high loads, low cylinder temperatures, and fuels of high sulfur content all mean a high corrosive wear.

He shows further that the solution is, quite simply, neutralization of the corrosive, that is, acidic elements in the oil before they can reach the iron of the cylinder.

Thus, he sees the primary function of high-additive oils as one of delaying the dangerous depletion of alkalinity and thus prolonging the antiwear protection several fold. He points out that these oils are especially effective if the make-up oil is very heavily compounded with alkaline additive.

When to Use High-Additive Engine Oils

BASED ON PAPER BY

J. A. Edgar, Shell Oil Co.

• Paper, "High-Additive Oils in the City, on the Long Lines, and Off the Road," was presented at the SAE National West Coast Meeting, Seattle, Wash., Aug. 15, 1951.

HIGH-additive oils are considerably more expensive than other types, so that added value must be received by the operator if their use is to be justified.

A study of operators' records, certain laboratory data, and work done by others indicates that the application of high-additive oils can be summarized as follows:

1. In city service (where engine life is generally limited by bore and ring wear and by oil ring plugging, which combine to destroy oil control), high-additive oil:
   (1) Positively prevents oil ring plugging.
   (2) Reduces bore wear to ½ or less.
   (3) Lengthens overhaul life to an extent that makes its use well worth while.
2. On long lines, high-additive oils are needed only infrequently to correct rogue cases of fouling and bore wear. In this case the equipment is well suited to the conditions of operation, so that corrosive wear is generally only a fraction of that found in city service, and ring plugging is far less frequent.
3. Off-the-road diesels are fully protected against failure by bore wear and fouling if high-additive oils are used, accompanied by full and realistic oil drain intervals.

In general, the serviceability of an engine will be increased by the use of a high-additive oil if the following conditions are met:

1. That engine life is now limited by oil consumption.
2. That the high-additive oil can reduce wear and ring plugging, thus delaying the onset of oil consumption.

City Service

As far as city-operated vehicles are concerned, they are oil-consumption-limited in the vast majority of cases.

That cylinder wear rate can be reduced by high-additive oils is shown by Table 1.

These data were developed from field tests of seven engines of a utility fleet operating on the Pacific Coast. Three engine makes are represented, all in the 200-240 cu in. class. The test procedure was (1) to open up the engines in the frames, (2) to measure the cylinders and note the deposits, and

Table 1—Comparison of Rate of Cylinder Bore Wear for Utilities Fleet with Heavy-Duty Oil and High-Additive Oil

	Operation with Heavy-Duty Oil			Operation with High-Additive Oil			
Engine Make	Total Mileage	Total Wear, in.	Wear Rate, in. per 10,000 miles	Total Mileage	Total Wear, in.	Wear Rate, in. per 10,000 miles	Average Final TBN-E of Oil
A	8,625	0.0029	0.0034	13,514	0.0010	0.0007	1.1
A	10,927	0.0055	0.0050	17,966	0.0016	0.0009	1.2
A	8,715	0.0034	0.0039	8,972	0.0007	0.0008	1.6
B	7,835	0.0036	0.0046	17,343	0.0054	0.0032	1.6
B	5,870	0.0034	0.0058	12,786	0.0024	0.0019	1.3
B	14,187	0.0057	0.0040	18,217	0.0042	0.0022	1.5
C	6,747	0.0034	0.0050	15,532	0.0070	0.0045	0.8
		Fleet average	0.0045		Fleet average	0.0020	

Table 2—Comparison of Rate of Cylinder Bore Wear for Delivery Fleet with Premium Oil and Two High-Additive Oils

	Operation on Premium Oil			Operation on High-Additive Oils[a]	
Engine Type	Total Mileage	Total Wear Rate, in. per 10,000 miles		Total Mileage	Total Wear Rate, in. per 10,000 miles
A	28,422	0.0045	followed by	9,549	0.0016 X[a]
A			new engine	6,747	0.0005 X[b]
A			rebored engine	9,716	0.0025 Y[a]
A	8,000	0.0064	rebored engine		
D	25,828	0.0023	followed by	10,463	0.0018 X
D	16,786	0.0033	followed by	7,400	0.0013 Y
E	37,555	0.0023	followed by	12,059	0.0004 X
F			rebored engine	11,082	0.0018 X
	Fleet average	0.0038		Fleet average	0.0014

[a] X is an experimental oil, Y is a commercial oil.
[b] Wear too little to measure with a micrometer.

(3) to reassemble the engines without change or cleaning.

It can be seen that the vehicles had run 5870 to 14,187 miles (from new) before the first inspection. Heavy-duty oils had been used in these engines from the beginning. High-additive oil was then put into the engines and use continued for additional mileages ranging from 8792 to 18,827, when a final inspection and measurement was made. The oil change internal was 1500 miles in both phases of the test.

It is to be noted that the wear rate decreases from 0.0045 in. per 10,000 miles with the heavy-duty oil to 0.002 in. with the high-additive oil—an overall benefit of about 50%. Thus, the indication from this fleet is pretty definite, that wear in intermittent service is greatly reduced when high-additive oil is used.

These tests did not show anything conclusive regarding the maintenance of open rings by high-additive oils. The heavy-duty oil had failed decisively to keep the rings open, so that when the high-additive oil took over, the conditions were already bad. The most that can be said is that the change to high-additive oil did bring some cleanup, even of the oil rings, as mileage was built up.

Data, however, from a second fleet consisting of door-to-door delivery units did give the information needed, for three of the units began the test on high-additive oils. (See Table 2.) Unfortunately, wear measurements were not as satisfactory as in the tests of the first fleet in that operational conditions did not always permit the oils to be tried successively in the same unit.

The high-additive oils were of two types, and were compared with a premium oil of high viscosity index. The operator's 2000-mile oil change policy was continued throughout all tests.

Not only did this series of tests show the unmistakable wear advantage of the high-additive oil but also that this type of oil does not allow rings to become plugged when it has been used exclusively. Further, its use improves conditions when it replaces other oils. For example, Fig. 1 shows that rings that are associated with the high-additive oils show no signs of blockage, contrasting sharply with the early plugging experienced when the premium oil is used. (Piston shown in center started factory new, while left- and right-hand pistons were from rebuilt engines, the oil rings of which were of a slightly different design.)

Fig. 2 illustrates the cleanup that occurred when a high-additive oil followed a premium type. (Unfortunately, the oil rings are the last element of the piston to feel the cleaning effect.)

The information obtained from these tests can also be used to estimate the lubrication and overhaul costs of a door-to-door, taxicab, pickup, private city conveyance, or similar vehicle. Fig. 3 shows schematically the lives of two similar vehicles operating in intermittent service with engines in the 225 cu in. class. One is lubricated by premium or heavy-duty oil and the other on a high-additive oil. When the engine uses premium oil it reaches its overhaul limit of 72 mpq at 50,000 miles. Having suffered about ½ as much bore wear (Tables 1 and 2) and having clean oil rings when the engines use high-additive oil, it should do at least as well as the

experimental engine tested by Geniesse,[1] that is, 442 mpq at the same mileage. Peak economy of the engine with premium oil is assumed to reach 2000 mpq at an age of 5000 miles. The peak economy with the high-additive oil is delayed by slow breakin, and is plotted arbitrarily at 15% below that of the engine with premium oil because the high-additive oil may be more volatile at a given SAE grade than the premium (although this is not necessarily so). Fairing the curves, then, gives a representation of the histories of the two engines.

By figuring total consumption plus drainage of not less than 4 qt at 2000-mile intervals, we find that the "premium" engine does well at first but consumption increases up to 27 qt in the last 2000 miles. The "high-additive" engine, on the other hand, winds up with a consumption-plus-drainage rate of 10 qt per 2000 miles at 50,000 miles.

Total oil purchased for the "premium" engine in 50,000 miles was about 75 gal, whereas for the "high-additive" engine it was about 45 gal.

Compared with other costs, however, oil expense is minor, and the added unit price of the high-additive oil is cancelled by its lower overall consumption. The extension of the life curve of the "high-additive" engine places its overall limit at upwards of 80,000 miles. The added life represents a saving of $225 per vehicle.

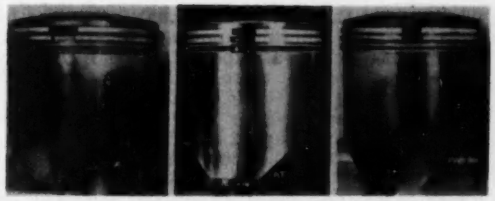


Fig. 1—Ring belt areas of center piston (experimental high-additive oil, 6746 miles) and right-hand piston (commercial high-additive oil, 9716 miles) have remained clean in contrast with ring plugging of left-hand piston (premium oil, 8000 miles)

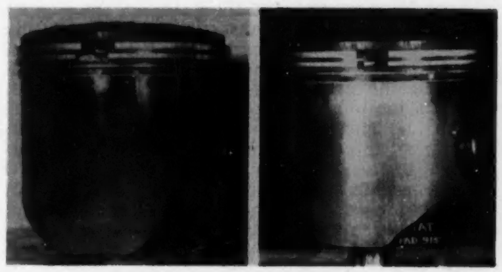


Fig. 2—High-additive oil did substantial cleaning job on right-hand piston; however, function of oil rings had not been hindered by previous usage. Premium oil, 28,422 miles (left) followed by 9549 miles on high-additive oil (right)

Over-the-Highway Service

The lubrication of engines used in over-the-highway trucks, particularly the long-line versions used in the West, is not nearly as difficult as that of the engines used in city service.

In the first place, the task of the lubrication engineer is made much easier because of the use of air cleaners and oil filters—to increase engine life. Further, the low engine temperatures and intermittent operation of the typical city vehicle are not prevalent. Hence, corrosive wear of the cylinder bores and rings is generally not great enough to unbalance their performance relative to the rest of the engine.

In his field testing, Pilger[2] has concluded that the 235 cu in. gasoline engines with which he worked were adequately lubricated with premium oils. In fact, he concluded that regular oil was sufficient if reasonable oil change periods (1500 miles) were observed. Oil ring plugging, moreover, was not improved when heavy-duty oils replaced regular oil, the rings remained fairly clean if they were of the right design. Some rings plugged badly with both types. Unfortunately, the experience reported by Pilger did not cover the use of high-additive oils, which Shell has found to prevent ring plugging entirely.

In 1949, a study[3] was made of a very large gasoline engine in highway transportation, where the wear rate with high-additive oil was compared with that of a good heavy-duty oil. Fig. 4 shows no change of wear rate when shifting from the one oil to the other. Rate of bore wear is very small in this high-grade engine and oil ring plugging never reaches a condition that would limit the overhaul life of the equipment in long-line service.

Valve trouble has often been mentioned as a penalty to be expected when high-additive oils are used, and since the smaller valve-in-head engines can be valve limited in heavy service, they should best demonstrate this phenomenon, should it exist.

Operators of a midwestern fleet of 70 trucks of the 235 cu in. size compared two high-additive oils with the heavy-duty oils regularly used. Valve life with the heavy-duty oil had been variable but a grand average was 31,100 miles. Two "high-additive" engines suffered valve trouble, on the other hand, at 19,800 and 18,000 miles. But one of these engines was over the 26,000-mile mark at the next inspection, and no concern was felt that abnormal valve life would be had in the long run. However, the owner was not satisfied with the 31,100-mile average, so he installed rotators and hard-faced valves in all the test units. Since that time only one engine has needed valve attention and that resulted from mechanical failure; some units had run over 80,000 miles at the last inspection. Cylinder bore wear has been very low on the 11 units inspected so far after mileages ranging from 42,852 to 68,791: 0.00061 in. per 10,000 miles for 7 units on high-additive oil; 0.00041 in. per 10,000 miles for four units on heavy-duty oils.

It is evident that these engines will not be overhaul-limited by bore wear. Indications are that

[1] See Oil & Gas Journal, Vol. 47, July 8, 1948, pp. 67-68, 71-73: "Motor Oils, 1948," by J. C. Geniesse and J. F. McGrogan.

[2] See SAE Quarterly Transactions, Vol. 2, July, 1948, pp. 354-368: "Field Testing of Motor Oil and Gasoline," by A. C. Pilger, Jr.

[3] See "Five Years' Experience with Special Heavy-Duty Oils," by J. A. Edgar and R. E. Jeffrey, Jr. ASTM Symposium on High-Additive Content Oils; Special Technical Publication No. 102; ASTM, Philadelphia, 1950.

bore wear in this service is adequately handled by heavy-duty oil. Oil rings and engines were, in general, perfectly clean, as expected, where high-additive oil was used, but there has been no complaint from heavy-duty oil either in this respect.

As far as 4-stroke-cycle diesel engines of large displacement and rugged construction are concerned, in the Thirties, these engines were regularly pushing toward 100,000 miles between overhauls for service in Western long-line transport, using regular mineral oil. In this service naphthenic oils were preferred because of their property of promoting piston cleanliness. When compound oils appeared, they had a mixed reception. Many approved of their dispersant character because the filter "socks" did not fill as rapidly, and the insides of the engines stayed cleaner. Others disapproved of circulating the solids, however, even though they might not deposit on the engine; in a sense the dispersant oil defeated the purpose of the filter. Auxiliary oil filters began to appear, and now their use is nearly universal. They have large capacity and high unit resistance, and so are capable of holding the solids content of the crankcase to a minimum.

In general, it seems, therefore, that high-additive oil is not needed for these engines in long-haul service, for entirely satisfactory operation is obtained with heavy-duty oil.

The 2-stroke diesel engine, which is becoming increasingly popular, does create thermal stresses in the cylinder zone that are much greater than those of the larger 4-stroke types, and the oil circulation to the ring belt is restricted to avoid wastage through the inlet ports. In these engines, lacquering of the pistons, ring wear and breakage, and bore wear are factors that need the attention of the lubrication engineer. Some laboratory tests have been reported to show that high-additive oil promotes piston crown deposits, which flute the cylinders in line with the inlet ports. Shell laboratory results do not show this condition. Further, a certain percentage of bus and long-line diesels of this type use high-additive oils, especially with regular-grade fuel, and experience good service with low maintenance costs.

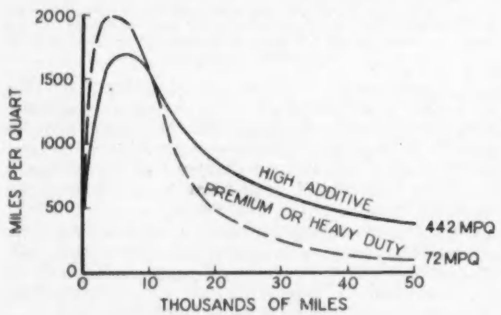


Fig. 3—Schematic representation of lives of engines operating on heavy-duty and high-additive oils

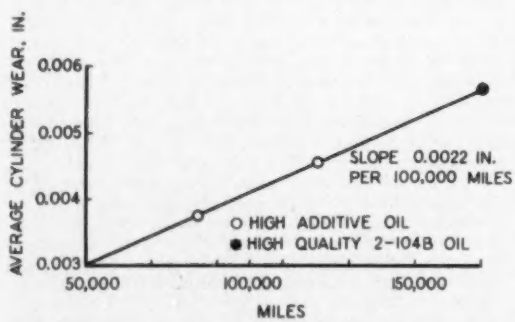


Fig. 4—Average cylinder wear in 707 cu in. engine operating 10,000 miles per month—rate of wear was unchanged in this engine when high-quality 2-104B oil followed high-additive oil

Off-the-Highway Service

A great deal of off-the-highway work is done in the West by trucks and cars. The condition of operation ranges from the heaviest duty to the lightest. Since individual operations can be recognized and classified according to the examples already given, this review of off-the-road operations will be confined to the diesel tractor and stationary engines.

These engines are the most massively built and longest-lived powerplants available for use in mobile equipment. Load factors range from 55% for earthmoving to about 90% in a proper stationary operation; and lives of 5000 to 10,000 hr are to be expected.

Where engine bearings and other wearing parts are engineered for carefree operation to such extended lengths, it is obvious that wear rates of cylinders and rings must be held to extremely small values or they will become limiting. It is for this reason that so much work has been done to improve the wear-preventive properties of crankcase oil for these engines.

It is well-known that the first cylinder problem of the tractor diesels was fouling and ring sticking. Metallic compounds were added to the oil and a miraculous improvement in cleanliness resulted.

It was found that in many cases a reduction of cylinder and ring wear was obtained, along with the improved cleanliness, when the heavy-duty oils came into use. When loads were very high or operation too hot or cold or the fuel quality poor, it was found necessary to reduce the oil drain interval in order to obtain satisfactory cleanliness and wear rates. In spite of the manifest expense in material and labor to change oil frequently, cases of 48- and 60-hr schedules are known, while 120-hr intervals are very common. These things occur, of course, because the heavy-duty oil expends its strength in accomplishing its cleansing and wear-preventive functions.

When high-additive oil is used, on the other hand, much better protection is obtained, especially when the proper make-up oil is used. Oil must be changed eventually, because of filter limitations.

(Paper on which this abridgment is based is available in full in multilithographed form from the SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

3 Requisites for Adhesives

EXCERPTS FROM PAPER BY

Seth Gunthorp, Consolidated Vultee Aircraft Corp.

• Paper, "Adhesion Engineering" was presented at the SAE National Aeronautic Meeting, Los Angeles, Calif., Oct. 4, 1951.

TO obtain a high quality adhesive bonded joint, an adhesive must fulfill these three requirements:

- The surfaces to be bonded must be wet by the adhesive.
- The adhesive must solidify.
- The solid must be strong and tough over a useful range of temperature and other service conditions.

1. Wetting

There are many indications that the adhesion of dissimilar materials such as paint, resins, adhesives, and glass to a metal is dependent on the presence of thin oxide films. It has been established that the first requirement for gross adhesion is molecular adhesion, which is usually spoken of as wetting. This means that the molecules of the coatings or adhesive must have a greater attraction to the surface in question than they have for each other. These forces of attraction cause the liquid to flow out and spread over the surface.

The established adhesives and coatings all are capable of thoroughly wetting the oxides of aluminum and iron. But there is doubt that perfectly clean surfaces of the metals themselves would be wet by these resinous materials. As an example, glass, which is a good adhesive under certain circumstances, bonds readily to steel having a thin adherent iron oxide film on its surface but will not bond to steel which has been thoroughly cleaned and deoxidized by heating in an atmosphere of hydrogen.

Experience has shown that paints and adhesives will bond vigorously to surfaces which are uniformly wettable by water, a characteristic of most clean oxide surfaces. Hence, spraying with a fine spray of clean water is a simple and universally useful test. Distilled water should be used in this test, and the part should be thoroughly dried prior to application of any adhesive.

Wetting will proceed at a rate which is somewhat dependent upon the mobility of the liquid. For example, methyl alcohol spreads much faster on clean glass than does glycerin. The chemical structures of these two liquids are similar but their viscosities or mobilities are different. The mobility of a liquid can generally be increased either by the addition of a solvent or diluent of low viscosity or by judiciously raising the temperature. Adhesives are made to wet the surface to which they are applied by either of these methods. If a solvent is used, it must be completely removed, prior to assembly, to prevent the formation of a spongy bond. With most adhesives, heating will after a time produce the opposite effect.

2. Solidification

The materials now in use as adhesives have been developed from two opposite extremes of physical properties. One of these extremes, the rubbery materials, is characterized by high elongation and a low but variable shear modulus which is dependent on elongation. The other extreme of physical properties belongs to the rigid resinous bodies. These exhibit low elongation and a high shear

IN his complete paper, Mr. Gunthorp explains that adhesives are being used more and more in aircraft. He reports, for example, that rubbery adhesives are being used instead of rivets to fasten trailing-edge skin to wing stiffeners. Riveted sheets wear themselves out in high-frequency vibration at the rivets. But the adhesives deform in shear, thereby reducing the peak stress in the metals and multiplying fatigue life of the bonded structure.

Gunthorp suggests, too, that modern high-strength adhesives might make it possible to build up large wing components from sheets and extrusions. At least, this method would require less material than machining from billets those parts which are too large to forge in current presses.

modulous, in some instances 1000 times greater than that of the unstretched rubbery adhesive. The practical adhesives now available are largely combinations of these two types, and they occupy a middle ground which embraces a large variation of stiffness and limberness.

In the cementing of rubber and rubber-like materials and in some high-quality adhesives for metal employing similar substances, the process of vulcanization is used to produce solidification sufficient for the purpose. In this process the long, chain-like molecules of the raw or uncured adhesive are chemically linked to neighboring chains by agents introduced for this purpose. Sulfur is used in natural rubber and in some synthetics. In others the metallic oxides perform this function much more effectively. The rate of vulcanization is greatly increased by heating and by the addition of small percentages of chemical accelerating agents. The physical nature of the resulting solid adhesive is largely determined by the amount of vulcanizing agent employed and the time, temperature, and pressure during the process of curing. In general, within the useful ranges, an increase of any one of these results in a stiffer, less deformable bond, and, if carried to extremes, may result in a joint which fails at low loads due to internal strains.

Where the resinous adhesives are employed, solidification is achieved by a process called polymerization which is somewhat akin to the action of crystallization of metals. This is a chemical process in which small molecules or groups of molecules join together in networks with links in random directions resulting in a strong solid when the process is carried out fully. This process is brought about by mixing two materials, which possess certain chemical structures, in the presence of a catalytic agent or promoter and simultaneously raising the temperature and the pressure. Solidification begins on certain molecules or groups of molecules and proceeds randomwise at rates which depend primarily upon the temperature but also to some extent on the catalyst and on the pressure. Polymerization probably begins at the surfaces (where the temperature is highest) and proceeds inwardly until all of the available molecules have taken their places in the structure or network.

3. Strength and Toughness

The third requirement for a good adhesive is high strength. The strength of an adhesive bonded joint (likewise a welded, brazed, or soldered joint) depends upon the nature of the bonding materials *after bonding* and upon the service conditions under which the joint must operate. The first is under the control of two manufacturing groups, namely, the adhesive maker and the fabrication shop where the bond is made or cured. The second is under the control of the designer, who can specify the proportions of the joint and the manner of loading.

The factors affecting the strength of the bond which reside wholly within the bond are functions of the rigidity of the cured adhesive, its intrinsic strength, the relative thermal coefficients of expansion, and the thickness of the bond.

The rigidity of an adhesive can be measured by its shear modulus, and this factor affects the strength of joints in a striking way. (In discussing the effects, it will be assumed that the adhesion to the bonded materials is the same for both high-modulus and low-modulus adhesives.) High-modulus materials such as phenol formaldehyde are very strong, and in shear joints load is distributed only to a very limited extent by stretching of the bonded material. This limited transfer of shear load results in sharp stress concentrations at the ends of the bond. The low-modulus materials such as synthetic rubber are less strong and deform considerably at low loads, which results in much more uniform stress in the bonded area.

If we can increase the strength of the bonding agent without losing its ability to deform slightly, the strength of the bond will be increased. As an example of this, joints made with rubbery adhesives and tested at low temperatures show significantly greater strength than those tested at elevated temperatures, the other variables held constant.

The thermal coefficients should be held as nearly identical as possible to minimize the preloading of the bond. For example, glass bonds easily to clean steel in air, and so long as the temperature is maintained fairly close to the solidification range of the glass, a bond of excellent strength is formed. However, upon cooling to room temperature the glass frequently fails without external loading or at very low loads. To eliminate this, it has been found necessary to match the coefficients of expansion of the metal and glass. The immediate result of this matching is the production of a strong joint.

The thickness of an adhesive bonded joint is, to a considerable degree, related to its strength. The optimum strength, in the region of 0.002 to 0.006 in. bond thickness, is about double that realized in joints of 0.020 in. thickness. These values are for tension joints.

This effect is also found in adhesive bonded shear joints. The mechanism may be explained by the following consideration. If a string 10 ft long is marked off in 1-ft lengths and loaded in tension, failure will occur at the weakest point. If the pieces of the broken string are now cut into nine 1-ft pieces, eliminating the two ends of the original break, and each of these is tested, the average will be higher than the value for the original failure. The likelihood of a weakness of a certain magnitude in a thin bond is thus lower than for a thick bond.

Another factor in this situation is the existence of a state of triaxial tension. Forces lying in the plane of the bond act to restrain the bonding agent from extension, and as a result failure does not begin within the bond. (This assumes a bond having no voids, discontinuities, or stress concentrations between the two bonded surfaces.) At the extreme ends and edges of the joint and particularly at corners, no such restraint exists. When sufficient load has been applied to stretch the bonding agent, failure begins at these points of minimum restraint and progresses throughout the bond. It is important that the bond not be too thin. Some thickness of the bonding material is necessary so that adjustment to deformation can be accomplished within the bond. A starved joint is never a strong joint.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Members of the Tooling Development Panel were (left to right): Secretary J. A. Maurice, manufacturing engineer, North American Aviation, Inc.; Co-Moderator K. H. Boucher, supervisor of design, Santa Monica Division, Douglas Aircraft Co., Inc.; R. W. Bechtol, chief tool designer, Consolidated Vultee Aircraft Corp.; Moderator H. V. Schwalenberg, chief industrial engineer, Santa Monica Division, American Aviation, Inc.; G. J. Walkey, manufacturing research engineer, Lockheed Aircraft Corp.; A. Kastelowitz, chief of manufacturing, research and development, Republic Aviation Corp.

Panel Provides Answers on Tooling Development

REPORTED BY

J. A. Maurice, Manufacturing Engineer, North American Aviation, Inc.

• Aircraft Production Panel on Tooling Development was held at SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1951, under the auspices of the SAE Production Activity. Moderator was H. V. Schwalenberg, chief industrial engineer, North American Aviation, Inc.

Question:

Since initial production tooling estimates for new-model airplanes must generally be prepared from limited engineering data—usually only preliminary specifications and proposal sketches—what basis for determining tooling requirements is most practical and factual?

Answer:

Systems currently in use for developing tooling estimates are at best professional "guesstimates."

Many companies are collecting statistics on ratio of airframe weight to the number of manufactured parts per airframe. These ratios considered with production rates and airplane types, it is hoped, will lead to more accurate estimating.

Question:

How useful is the combination of optical instruments and tooling docks?

Answer:

Development of the use of optics in conjunction with the tooling dock will bring tangible benefits to the airframe industry.

Many dock-built tools are moved considerable distances. Optical instruments are a simple, accurate means for checking a dock-built master or assembly fixture away from its point of manufacture.

Question:

What has been the reaction of the man in the shop to use of optical checking equipment and

the new techniques of fixture alignment that go along with its use?

Answer:

At Republic Aviation, at least, the reaction has been favorable. At first, a few simple tools were built using optical equipment in the midst of tools being built by conventional methods. Workmen soon recognized the advantages of the optical system, and its acceptance was virtually automatic.

Question:

Is it economical to use optical instruments in the construction of medium-size and small-size fixtures?

Answer:

Optical instruments have been used economically with tools as small as 10 ft in length, especially where design was complicated and tolerances close.

Question:

Do these optical instruments have any use other than alignment of fixtures?

Answer:

Optical instruments have been utilized successfully for checking and setting machine tools. The collimator and telescope in conjunction with an optical square (penta prism) provides a speedy and economical means of checking the accuracy of longitudinal, vertical, and transverse ways of such machine tools as planers, milling machines, and engine lathes.

Question:

Does the accuracy obtainable with optical instruments make it possible to eliminate master tools?

Answer:

Yes, in some cases where only one or two airplanes were to be built tool masters have been eliminated. But it is not recommended for larger quantities.

An optical system can easily be incorporated into a tool mastering program. Tool masters fabricated using optical instruments and the standard three or more reticle line-of-sight system can be accurately and economically aligned during both fabrication and use.

Besides, optical equipment makes it possible to build large tool masters in sections and subsequently assemble them in accurate alignment.

Question:

What is the German "hole production method?"

Answer:

This is a system involving a rigid monococque master body duplicating the structural components and configuration of a portion of the airframe. Through a system of coordinated holes and trim lines in the master body, under-size hole patterns are drilled in production components, which are subsequently cleco-assembled, redrilled, and riveted.

Republic Aviation has a contract with the Air Materiel Command to evaluate this method.

Question:

How are plastic materials used in the fabrication of tooling for the manufacture of metal aircraft components?

Answer:

Foamed phenolic material is cast to the rough shape of the die which it will core. Or it is cast in rectangular blocks and cut to rough shape. Cutting can be accomplished with an ordinary woodworking machine.

Foamed core material is cast or cut to rough shape with an allowance of approximately 2 in. for a fill of casting resin to finish contour. The core is attached to a metal base plate with lag or wood screws. Then the core is mated to the plaster master, and the cavity between is filled with casting resin. The resin adheres readily to the rough core surface.

This procedure is simpler and requires less labor than the conventional wire-and-plaster core method.

To repair a phenolic cast resin tool, worn areas are chipped away and recast against the

plaster master. Changes are made similarly. Either can be accomplished overnight, and there is no sacrifice of strength.

contours. (A "control master" is a self-contained rigid unit which duplicates critical points held by a tool master. The control master is used when there must be several tool masters, such as when the same parts are to be produced at several plants.)

Question:

How does cost of making aircraft tools from plastic material compare with costs with metals?

Answer:

Casting resins shrink so little that there is no need for shrink patterns and the final finishing of the die surface is greatly reduced. This saves labor costs.

The weight savings result in money savings, too. For example, in one case a 1¾-ton cast phenolic resin stretch press die is doing a job that would require a 17-ton die if the die were made of kirksite. The plastic tool costs less. And it is much cheaper to handle.

Question:

What part can plastic tooling play in the conservation of critical material?

Answer:

Use of plastics saves the zinc in the kirksite which would otherwise be used. And plastics can substitute for considerable amounts of kirksite. For example, one West Coast manufacturer used 197,000 lb of phenolic casting resins for tooling purposes over an 18-month period. The same tools made up in metal would have required over 1,000,000 lb of kirksite.

Question:

What is a "tool master?"

Answer:

A tool master is a rigid self-contained unit which duplicates points to be held on assembly jigs and fixtures used to fabricate an airframe. A tool master plaster pattern additionally holds

Question:

What precautions do you take to insure good tool masters?

Answer:

Special groups within the design department design the tool masters, and drawings are double-checked before release. Tool masters are double-inspected during fabrication. And tool masters are never used for manufacturing parts or assemblies.

Question:

If there is disagreement between the master tool and the engineering print, which is changed? Or do you leave the contradiction?

Answer:

In some instances the master tool is changed, and in some instances the engineering print is changed. It depends largely on how many airplanes have already been produced to tooling coordinated to the master tool and whether the change would affect the airplane itself.

Question:

What methods are used to maintain interchangeability of parts and assemblies?

Answer:

The best way is to identify interchangeable items all the way from the design stages of the tooling through to the finished part or assembly. It helps, too, to keep everyone concerned with design, fabrication, or use of tools for these items reminded that the tools' finished products must be interchangeable. Of course, management must see that workers and machinery are capable of working to the tolerances necessary for interchangeability.

SOME SAE COMMITTEEMEN are in action on every working day of the year. Nearly 3500 right now are contributing as National or Section officers or committeemen.

Here are a few more added to our "Men at Work" gallery from recent National Meetings.

W. P. Michell, chairman, SAE Truck & Bus Technical Committee

R. K. Hatch (left) and Chairman Charles C. Hudson, Rating of Winches Subcommittee of the SAE Transportation & Maintenance Technical Committee

Technical Board Sponsor H. L. Rittenhouse (left) and Chairman E. F. Norelius of the Construction and Industrial Machinery Technical Committee

Chairman Emil P. Gohn and J. L. S. Snead, Jr., of the Instrument Panel Grouping Subcommittee of the SAE Truck & Bus Technical Committee

Chairman J. V. McNulty, Aircraft Gas Turbine, Ram-Jet, and Rocket Engine Ignition Subcommittee of the Ignition Research Committee

ISTC Division XXXI
Summary of Experience with

Centrifugal Casting

THE use of centrifugal force in casting metals may confer several advantages both in economy of production and in quality of the castings. Metal freezing in a spinning mold freezes under pressure due to the centrifugal force. This pressure is selective in that the greater force is exerted on the denser components. This effect is of considerable benefit in eliminating non-metallics and gases during casting. Directional solidification is promoted by centrifugal casting because the colder, denser metal is thrown to the outside away from the spinning axis while the hotter, less dense metal accumulates nearer the axis to act as a feeding reservoir.

Limitations of centrifugal casting are that it is most advantageously applied only to certain convenient shapes and that the casting and spinning equipment required is justified only for repetitive mass-production parts.

True centrifugal casting is used for cylindrical parts. The mold is rotated usually in the horizontal plane. Molten metal introduced into the revolving mold is thrown to the mold wall, where it is held by centrifugal force until solidified. A perfectly cylindrical interior is thus formed without the use of a center core. The true centrifugal process owes most of its historical background and technical development to the cast-iron pressure-pipe industry. Centrifugal cast-iron pipe is produced in 5 to 20 ft lengths and in diameters up to 48 in.

Disc- or wheel-shaped parts are cast by what is termed the semicentrifugal process. The mold is spun about the vertical axis, and metal is introduced into a down-gate at the center of the mold (Fig. 1). Centrifugal force throws the liquid metal to the periphery, and the pressure generated is of some aid in feeding the rim sections and in eliminating gas porosity.

Odd-shaped parts not adaptable to other centrifugal processes are cast by the centrifuge method. Mold cavities are positioned at the periphery of a revolving turntable, the metal is introduced at the center and led into the molds by radial sprues. The increased fluid pressure is of some value in completely filling the mold. Centrifuging is sometimes used in connection with precision casting.

THIS report was prepared for the Executive Committee of the SAE Iron and Steel Technical Committee. Both the ISTC Division XXXI—Centrifugal Castings, whose chairman wrote the article, and the ISTC Executive Committee approved the article.

Spinning Speeds and Calculations

For true centrifugal casting, spinning speeds are commonly calculated as centrifugal force in "g" or "times gravity."

$$g = \frac{N^2 \, Dia}{70{,}500}$$

Where g = units of acceleration due to gravity = 32.2 ft per sec per sec at standard conditions
N = spinning speed, rpm
Dia = diameter, inches

The term "g" is the number of pounds of centrifugal force per pound of metal. For commercial castings of iron or steel the usual range of "g" values is from 40 to 100. Using 60 g, a 3-in. diameter casting is spun at 1190 rpm, a 10-in. diameter casting at 650 rpm and a 30-in. diameter casting at 375 rpm. Insufficient centrifugal force will not "pick up" the liquid metal quickly, and excessive centrifugal force may cause hot tears in the barely solidified metal. For thick-walled cylinders a compromise must often be effected so as to have barely sufficient "g" at the inner diameter and yet not excessive "g" at the outer diameter.

With horizontal axis spinning, the interior cavity is a true cylinder. With vertical or inclined axis, the interior surface is paraboloidal, the parabola becoming more slender and approaching cylindrical as spinning speed is increased or angle of inclination to the horizontal is decreased. A general formula defining the shape of the interior surface developed

# of Ferrous Metals

REPORT BY

C. K. Donoho, Chairman of ISTC Division XXXI—Centrifugal Castings, and Chief Metallurgist, American Cast Iron Pipe Co.

in a liquid under centrifugal force at a section through the axis is:

$$H = \left(\frac{0.000142\ N^2}{\text{Sin}\ B}\right) R^2$$

H = height above vertex, in.
N = spinning speed, rpm
B = angle of inclination of axis
R = radius of cavity, in.

Fig. 2 shows several calculated parabolas for vertical-axis spinning. With a cylindrical casting spun vertically at 600 rpm, if the mold opening at the top is controlled to 4-in. diameter, in a 10-in. length there will be a taper to about 3 in. diameter at the bottom. With a short ring section spun vertically, the taper will be negligible.

Mold Materials

Sand molds are widely used in the true centrifugal casting of iron or steel cylindrical bodies. A rigid metal flask adaptable to the spinning mechanism is used, and the sand mold is rammed about a pattern concentrically inside the flask. (See Fig. 3.) Metal molds, steel or cast iron, are also used. In a widely

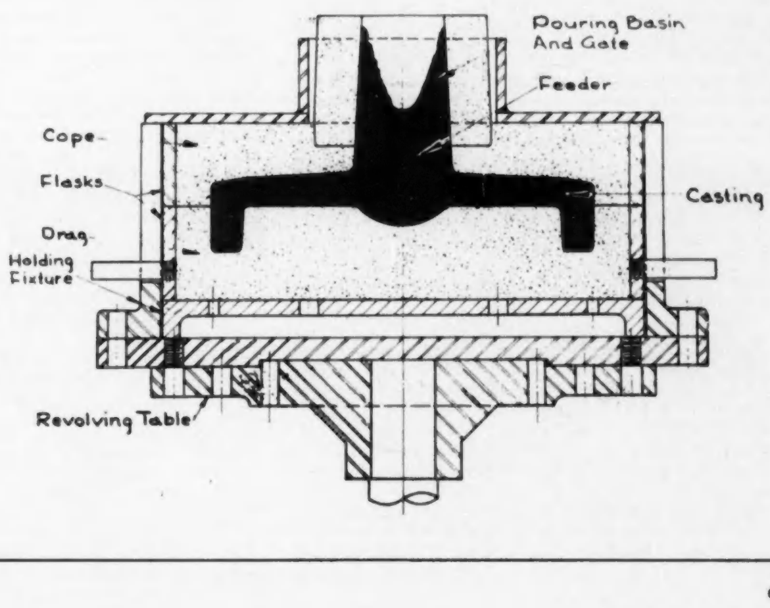


Fig. 1—Semicentrifugal casting of flywheel

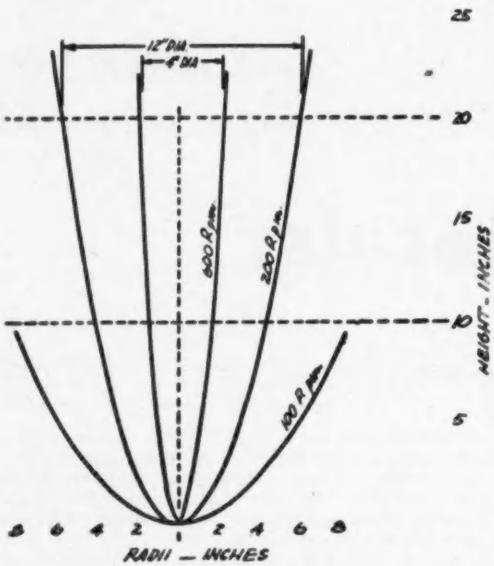


Fig. 2—Calculated shapes of cavity for vertical-axis spinning

used commercial pipe process, the molds are enclosed in a water jacket for continuous cooling. Metal molds are usually coated with a refractory mold coating forming a thermal barrier to protect the mold and where gray iron is the metal cast, to reduce the chilling against the mold wall. There is often little distinction between a sand-mold process where the metal flask has a thin sand lining and a metal-mold process where the metal mold has a thick refractory coating. In general, however, the sand mold process is used (1) where the metal is introduced in one end of the mold to flow a long distance over the mold surface; (2) where chilling of gray iron is undesirable; and (3) where outside diameters may be varied slightly with the same flask equipment. Metal molds are often more economical where large quantities of identical castings are to be made. Metal molds assist in achieving directional solidificiation, and are more effective where rapid cooling with attendant fine as-cast grain size is desirable, as in some austenitic alloys.

Metals Cast

Gray cast iron is centrifugally cast in large tonnages. Its relatively low pouring temperature and good fluidity make it readily adaptable to all the various centrifugal methods. Parts produced centrifugally from gray iron include pipe, rolls, cylinder sleeves and liners, piston ring pots, bearings, bushings, etc.

Since the beginning of World War II there has been a substantial development in centrifugal casting of steel. Wartime shortage of forging capacity provided the impetus to produce high-quality parts by casting. Cylinder barrels, gears, rolls, bearing backs, heavy tubing for many uses, and cylindrical stock for machining turbine parts have been produced by centrifugal casting in some quantity.

Malleable iron is not centrifugally cast to any large extent, although some cylinders and piston ring stock for heavy-duty service have been cast as white iron in metal molds and then annealed to a pearlitic malleable structure.

The newly developed nodular iron has been found to be amenable to centrifugal casting in either sand or metal molds. In the latter case annealing is necessary, but annealing is preferable even in the sand casting to develop the best ductility and toughness. With hypereutectic nodular irons the graphite nodules are centrifuged to the inside surface. (See Fig. 4.) This does not occur with hypoeutectic irons.

Stainless and heat-resisting alloys are centrifugally cast to produce tubes and cylinders. Many of the most desirable alloy compositions are quite difficult to roll and forge, and centrifugal casting has proved to be an efficient and economical method for producing tubes and cylinders in special compositions and heavy-walled tubing in the common alloys. A recent important development is the centrifugal casting of alloy ring stock for machining into annular turbine components.[1, 2]

At least one producer makes commercial dual-metal true centrifugal castings with one metal on the outside of the section and a different metal at the inside of the section.[3] Several combinations of hard and soft cast iron, carbon steel, stainless steel, and copper-base alloys have been successfully produced. The bonding between two metals is said to be complete and continuous.

Quality Considerations

Centrifugally cast gray iron is in general more free from gas porosity and shrinkage but otherwise is not intrinsically different from iron cast in static molds. Metal-mold centrifugal cast iron is often chilled so that annealing is required for adequate machineability and toughness. Such chilled and annealed gray iron structures have been found to have much lower wear resistance in such applications as cylinder liners than does the normal flake-graphite pearlite structure obtained in sand castings. In some instances this has brought about a mistrust of centrifugal castings for such applications, although the undesirable structure is simply due to freezing rate and not to the centrifugal process itself. Cylinder liners with good structure and wear resistance can be cast centrifugally either in sand molds or in heavily coated and/or preheated metal molds. (See Fig. 5.)

Centrifugal steel castings have been termed "liquid forgings." This is, of course, a misleading description since metal solidified directly from the liquid, whether under centrifugal force or not, is

[1] See "Product Engineering," Vol. 21, No. 11, Nov., 1950, pp. 112-116: "Centrifugal Casting in Permanent Molds," by Warden F. Wilson.
[2] See "Machine Design," Vol. 22, No. 11, Nov., 1950, pp. 131-132: "Centrifugal Casting for Critical Components," by Herbert Cooper.
[3] See "The Foundry," Vol. 79, No. 7, July, 1951, pp. 78-79, 218, 220, 222, 224 and No. 8, Aug., 1951, pp. 84-89: "Some Recent Developments in Centrifugal Casting," by M. L. Samuels and A. E. Schuh.

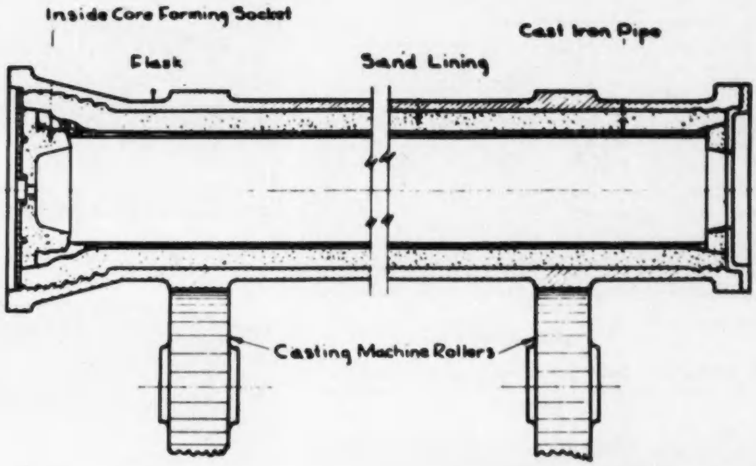


Fig. 3—True centrifugal mold for making cast-iron pipe from "Centrifugal Casting of Steel" by S. D. Moxley in ASME Transactions, Vol. 66, Oct., 1944, pp. 607-614)

cast metal with the typical structure and properties of cast metals. Cast steel is distinguishable from rolled or forged steel in that the inclusions are random and not elongated in the direction of rolling. Cast steel bodies, therefore, show little or no direction ability of properties. Grain refinement in cast steels is achieved by heat-treatment only.

The usual tensile properties quoted for cast steels and rolled steels show higher ductility for the rolled steels. If the rolled steels are tested transversely to the direction of rolling, however, the ductility is usually lower than for a cast steel of comparable hardness. The ductility of sound cast steel is about

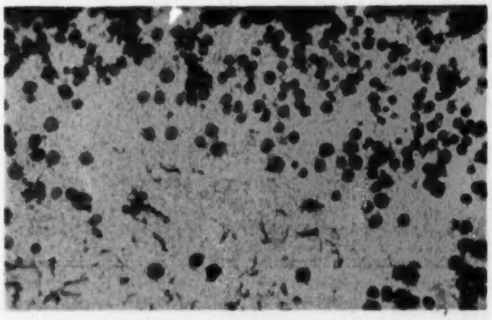


Fig. 4—Microphotograph of inside diameter of centrifugally cast nodular-iron pipe. Hypereutectic iron. Unetched specimen. Inner surface is at top

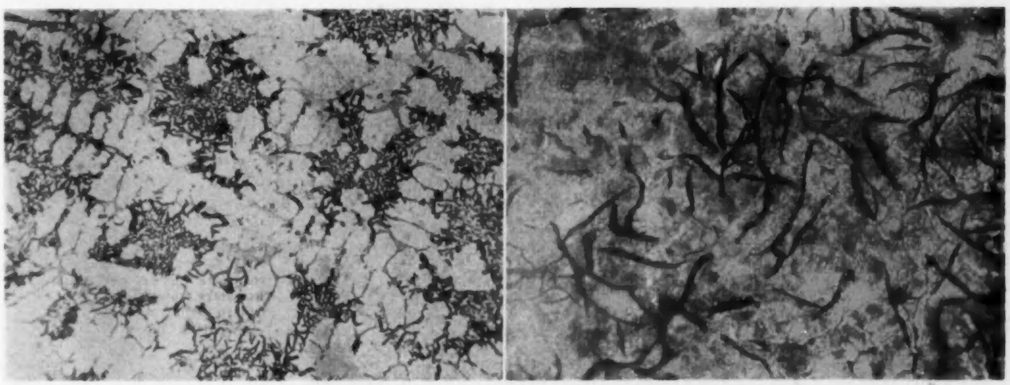


Fig. 5—At left, structure of metal-mold centrifugally cast iron cylinder in annealed condition. At right, structure of sand-mold centrifugally cast iron cylinder as cast. Both specimens etched in nital

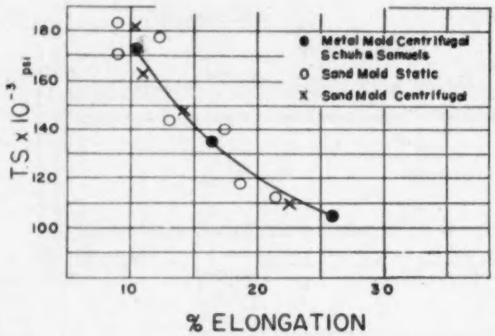


Fig. 6—Comparison of tensile strength versus elongation of SAE 4140 steel cast in static sand molds and in centrifugal sand molds and metal molds

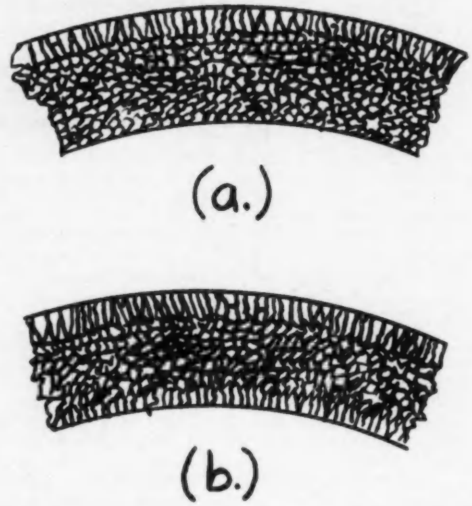


Fig. 7—Top, diagram of freezing from outside surface only. Bottom, diagram of freezing from outside and inside surfaces

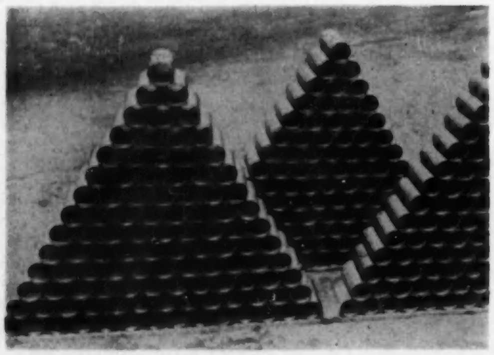


Fig. 8—Centrifugally cast alloy-iron cylinder liners for diesel engines

the same as the average of the longitudinal and transverse ductilities of rolled steel.

There is no evidence known to the writer that centrifugally cast steel is superior in any way to statically cast steel of equivalent soundness. Often centrifugal casting is the most expedient way to produce the requisite soundness, but there has been great progress in the science of risering and feeding of static castings to produce sound parts, and when this is achieved the parts are equal in quality to those produced by any other method.

Many advantages are claimed for the use of metal

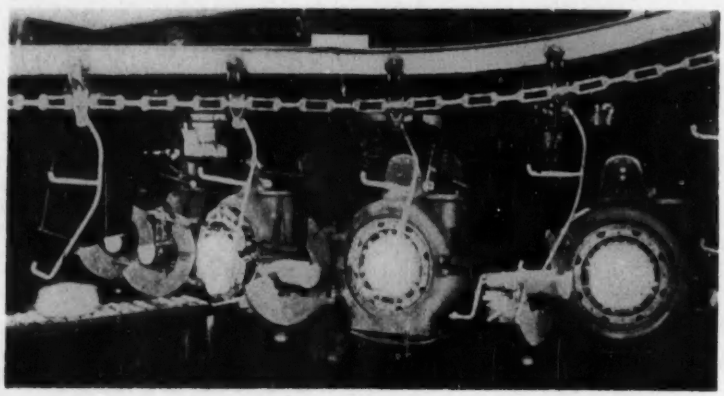


Fig. 9—Production of composite steel and cast-iron brake drums by centrifugal casting at Motor Wheel Corp.

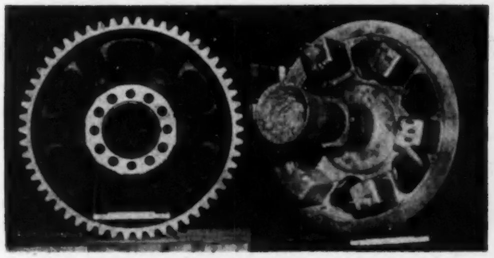


Fig. 10—Steel gear castings with risers

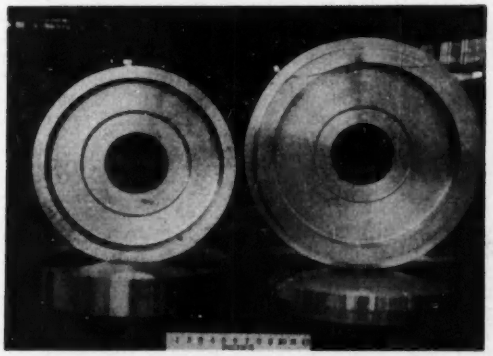


Fig. 11—Machined cast-steel flywheels

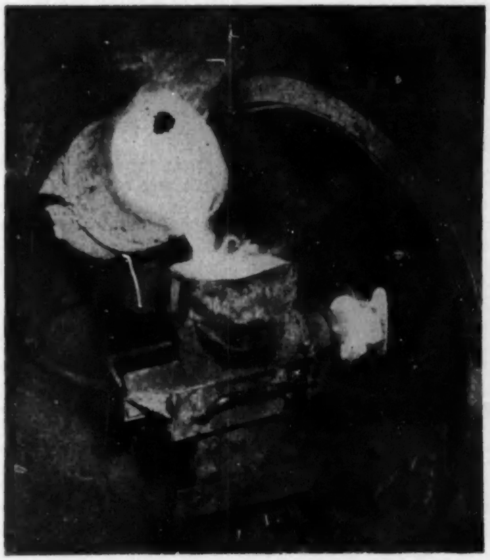


Fig. 12—Pouring cylinder barrel

Fig. 13—Alloy-steel cylinder barrels as cast, rough machined, and finish machined

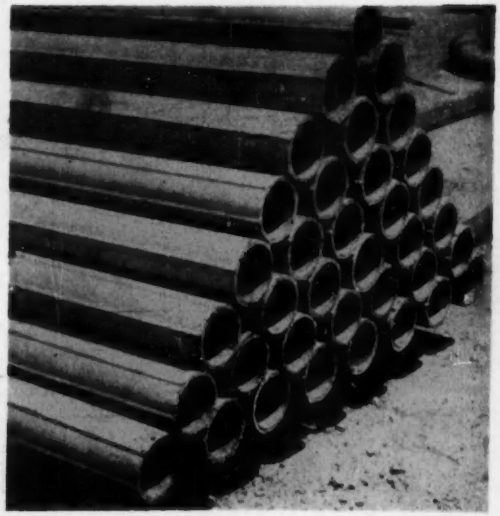


Fig. 14—Fluted tubes centrifugally cast in 16-ft lengths

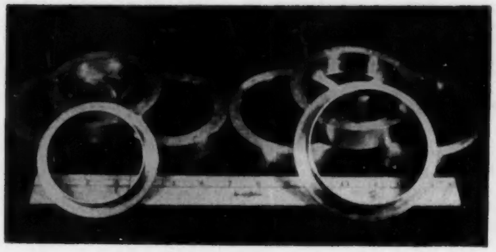


Fig. 15—Typical ring sections machined from centrifugally cast 16-ft-long tubes

Table 1—Tensile Properties of Oil-Quenched Sections from a Metal-Mold Centrifugal Steel Tube of SAE 4140

Draw Temperature, F	Tensile Strength, psi	Yield Strength, psi	Elongation, %	Reduction in Area, %	Hardness, Rockwell C
1290	104,900	92,600	25.9	51.2	18.8
1150	138,100	122,600	16.1	40.0	28.0
950	174,700	163,600	10.5	28.8	37.3

Table 2—Tensile Properties of Oil-Quenched Sections from a Sand-Mold Centrifugal Steel Tube of SAE 4140

Draw Temperature, F	Tensile Strength, psi	Yield Strength, psi	Elongation, %	Reduction in Area, %
1275	109,600	82,300	22.8	55.8
1125	154,100	138,400	14.1	41.7
1000	162,300	148,800	11.2	33.9
900	182,000	173,700	10.7	28.9

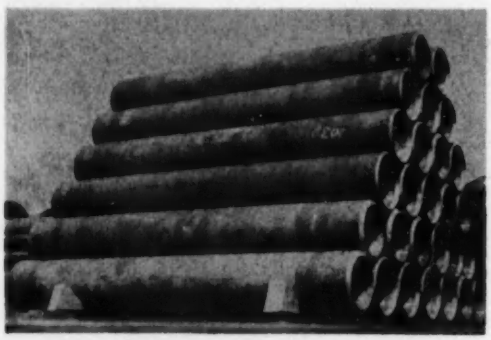


Fig. 16—Retorts of 28%-chromium, 15%-nickel heat-resisting alloy steel

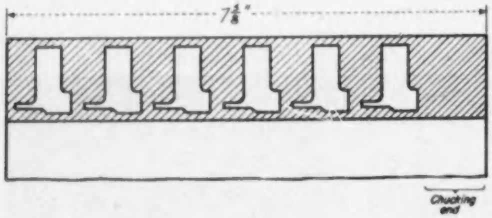


Fig. 17—Rings used in jet engines show economy of cutting multiple units from one blank (from "Centrifugal Casting in Permanent Molds" by Warden F. Wilson in Product Engineering, Vol. 21, No. 11, Nov., 1951, pp. 112-116)

molds in centrifugal casting of steel. It is true that there is somewhat less danger of mold cutting and washing, although where the metal molds are refractory coated there can be almost as much trouble from entrainment of the facing material as could be expected in sand-lined molds. In Table 1 are shown tensile properties obtained by Samuels and Schuh[3] on specimens cut from a metal-mold centrifugally cast tube. The steel is SAE 4140 and the specimens were heat-treated by oil quenching and tempering as indicated. Table 2 shows similar tests made at the American Cast Iron Pipe Co. on a sand-mold centrifugally cast tube of the same alloy steel. The ductility level is essentially the same. In Fig. 6 are plotted tensile strength versus elongation values for both sets of data plus some values for static castings selected from the Steel Castings Handbook.[4] It can be seen that there is no essential difference in the ductility at a given strength level obtainable in metal-mold centrifugal, sand-mold centrifugal, or in sand-mold static castings.

It is ordinarily considered that true centrifugal steel or alloy castings never exhibit shrinkage, and it is true that the nature of the process promotes directional solidification and tends to prevent the centerline shrinkage often found in the static castings. In heavy-walled tubing however, if a continuous band of frozen metal is formed at the interior surface at the same time that freezing is progressing from the outside surface, shrinkage will occur between the two waves of solidification. In Fig. 7, (a) shows freezing from the outside surface only and (b) shows freezing from both surfaces where shrinkage may occur between the two. Prevention of freezing from the inside surface is accomplished by several methods: slow pouring to allow progressive freezing from the outside as the section is built up; use of an exothermic material or insulating material or both on the interior surface to retard freezing from the inside; closing the mold

[4] See Table 56 on p. 360 of Steel Castings Handbook, 1950 edition, published by Steel Founders' Society of America.

at each end to exclude air currents on the interior surface. With such precautions a freezing pattern like Fig. 7 (a) can be obtained in true centrifugal castings over 4 in. thick.

Examples

Results of a questionnaire sent out by Division XXXI indicated that the principal automotive uses of centrifugally cast gray iron are: cylinder liners or sleeves, brake drums, and piston rings. Fig. 8 shows centrifugally cast alloy-iron cylinder liners for diesel engines. These are cast individually in coated metal molds in horizontal-axis casting machines. As pointed out previously, in such castings the freezing rate must be so controlled as to produce a normal graphite-pearlite structure at the wearing surface. Fig. 9 shows an operation of centrifugal-casting gray iron on a steel band to form composite brake drums of gray iron fused to steel.

Steel parts cast centrifugally include gears, flywheels, tractor rollers, radial engine cylinder barrels, cylinder sleeves, and ring and tube stock for varied uses. The gear casting shown in Fig. 10 was centrifugally cast by vertical-axis spinning. There is little advantage in spinning such shapes where risers over each spoke junction are required to feed the rim section, and many steel foundries prefer to cast such parts in static molds. The flywheels in Fig. 11 were cast with vertical-axis spinning and gated as shown in Fig. 1. In these castings the center section was cast thick enough to feed the rim without risers. Caine[5] estimates that gears can be cast satisfactorily sound by vertical spinning where the ratio of rim section to spoke section does not exceed 1.2 to 1.

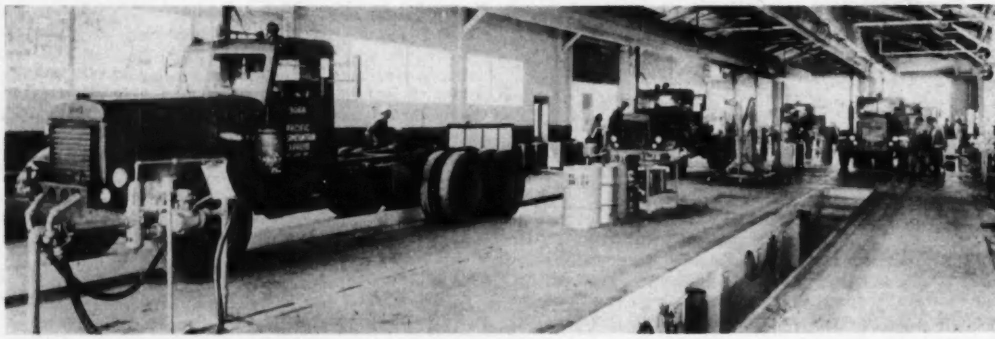
Radial engine cylinder barrels centrifugally cast in metal molds with horizontal-axis spinning were produced in vast quantities during World War II. Fig. 12 shows one operation of casting such cylinders and Fig. 13 shows the rough casting and two stages of machining.

Steel tubes are centrifugally cast in various lengths up to 16 ft for a variety of uses. Fig. 14 shows centrifugal tubes with a special outside contour which are cut into rings for starter motors. Fig. 15 shows typical ring sections machined from centrifugally cast long tubes.

High alloy tubes such as shown in Fig. 16 are produced economically by centrifugal methods. Ring-shaped parts for gas turbines and jet engines are produced from centrifugally cast high alloy stock. One example is shown in Fig. 17.

Centrifugal casting does not produce cast metal parts of a quality intrinsically superior to what may be produced by conventional casting methods, but for the more suitable shapes centrifugal casting is often the most expedient and economical method for producing castings of the requisite quality and soundness.

[5] See "The Foundry," Vol. 71, No. 5, May, 1943, pp. 90-93, 175-176: "Centrifuging After the Mold is Filled with Steel," by W. F. Wright and J. B. Caine.



Tractor servicing carried out on a production line basis. Typical operations performed on this line include: washing and steam cleaning; tire matching and inspection; lubrication and oil changes; and headlight, electrical system, and battery tests. As each job is completed, the mechanic performing the work registers this fact in the logbook assigned to each tractor

Maintenance-Servicing System Set Up on Production Line Basis

EXCERPTS FROM PAPER BY

A. L. Springer, Pacific Intermountain Express Co.

• Paper, "A Garage Set Up for Production Line Preventive Maintenance," was presented at SAE Northern California Section Meeting on Sept. 26, 1951.

PACIFIC Intermountain Express management realized in 1947 that a large and efficient preventive maintenance program had to be set up if expansion plans were to be met. It was decided to set up a maintenance-servicing system on a production line basis.

Our goal was to achieve maximum utilization of line haul equipment and shop personnel. Therefore, it was planned to do major work at Denver—the center of our system. Secondary service shops would be located at end stations and an enroute service shop at Salt Lake City. To achieve this utilization, no assemblies were to be worked on while installed in the equipment.

To keep an accurate account of the 75 to 100 schedules expected to run through this line, we established a Records Section—organized around the use of a logbook carried in each tractor and trailer. Through use of a vehicle logbook, we are able to (1) coordinate all shop activities as they pertain to each vehicle, and (2) supply a current report of service accomplishments to the Records Section for assimilation and analysis. Information, to be complete, must come from both the driver and the maintenance service foreman. Therefore, the logbook—padded with sufficient duplicate page sets to allow accumulating a record of all work accomplished between major overhauls—contains a Driver's Trip Report on the front side and a Service Report on the reverse side.

The General Shop is located on 12 acres of ground along with the Denver District terminal facilities, considered two separate installations to prevent interference with the operation of the terminal dock and office. Sufficient space has been allowed in the rear for parking trailers by pulling them straight in, thus eliminating the old, slow back-in method of parking trailers against the fence. This saves much time and trouble in our hostling operation.

The building is 240 ft wide and 200 ft long, and is completely heated by radiant heat. There are two tractor and two trailer service lines, each 20 ft wide and 200 ft long. The first line is designated the "slow" line. The No. 2 line, known as the "fast" line, is for vehicles which require only a minor inspection or minimum amount of work. There are no posts between the lines so the vehicles may be moved from one line to the other if required.

Every tractor is steam cleaned and washed at the first position on either line. The second position on the slow line contains the chassis dynamometer. It is used whenever there are any power or vibration complaints and for all major checks. The next position is equipped to handle all wheel packs, tire matching and inspection; next are positions for testing headlights, electrical system and batteries. A complete inspection of the chassis and cab is also made at this point. The vehicle then moves to the lubrication pit where the oil changes, transmission grease changes, and lubrication is completed—depending on the inspection required (as indicated in the logbook). As each job is completed, the mechanic must initial the logbook to signify completion of the work.

When the vehicle arrives at the end of the line, a final check is made of all safety equipment, fuses, chains, first aid kits, fire extinguishers, and so forth. The service foreman completes the logbook, makes the final inspection, and notifies the system dispatcher that the vehicle is ready. The service foreman cooperates with the system dispatcher by forecasting when the vehicle will be ready approximately 45 min before the anticipated completion time.

The trailer service line is very similar to the tractor service line. The trailers are moved through the shop by a specially built hostling tractor. In the first position the steam cleaners wash all landing gear and running gear parts, and apply soap to the front and rear of the trailer. The trailer then moves through the automatic van washer where the sides and roof are washed and the front and rear rinsed off. Result — a completely clean trailer in 9 min. The trailer is parked in the next position for a minute or two to allow it to drain. Due to the low humidity in Denver and the radi-

ant heat in the winter time, it takes but a few minutes to dry.

At this position a visual inspection is made of the trailer to determine what repairs are required in addition to the regular inspection. It then moves to the next position where the lights are checked, running gears completely inspected, and tires checked and changed as needed. The next move is to the lube island where the trailer receives wheel packs and grease jobs as required by the trailer logbook. The service shift foreman now notifies the system dispatcher when the trailer service will be completed. He also fills out the logbook before releasing the trailer to the district hostler.

Small parts are stored on the service floor so the mechanics do not have to go continually to the stores window, thus saving time for both mechanics and stores personnel. Likewise, tire racks are placed in the tire changing areas for easy access by the tire men.

The stores area is located in the center of the shop between the service and overhaul sections. This eliminates a lot of walking by the mechanics and stores personnel. All parts are received by the stores, no parts are delivered directly to an employee on the floor. In this way we have an accurate record of what was received, its condition, and conformance to orders. A perpetual inventory control is maintained.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Why Electronic Road Test Panel Was Needed

Excerpts from paper by

R. R. PROCTOR

Pure Oil Research and Development Laboratories

RAPID acceptance and increasing possibilities of the Borderline Method of Fuel Rating brought about the development of the electronic road test panel.

This Method provides a means for determining the octane rating of a fuel throughout the entire speed range of an engine. Briefly, the fuel rating is determined by plotting a framework of reference fuels and superimposing the unknown fuel on the framework to determine its octane rating at any speed.

All fuel runs are made in a car in which the distributor governor and vacuum advance have been locked out and a manual control installed. The distributor is first set so that ignition occurs at a known point somewhere near top dead center.

With the car in high gear and running at 8 to 10 mph on a level road, it is accelerated at wide-open throttle and the speed at which knock fades out is recorded. At least two check runs are made, or more if necessary, until the same fade-out speed is agreed upon by two observers. The spark is then advanced two degrees and the procedure repeated, then two more degrees, and so on, until a complete curve has been plotted for speeds up to 70 mph.

It should be obvious that some sort of instrumentation is required to determine the spark advance each time it is changed or, conversely, to set the spark at any given point accurately and easily. An engine rpm indicator is desirable since (1) it is easier to work with engine rpm rather than mph, and (2) the standard speedometer is not ordinarily accurate enough for this type of work.

With this required instrumentation in mind, researchers came up with an instrument which would indicate both engine rpm and spark advance. And these are the basic circuits used in today's road test panels.

(The author analyzes and describes this instrument in his paper.) (Paper, "The Electronic Road Test Panel," was presented at the SAE Mid-Section Meeting on May 15, 1951. It is available in full multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

New Lube Oil Filter Has Dual-Flow System

Excerpts from paper by

CHARLES A. WINSLOW

Winslow Engineering Co.

FULL-FLOW engine oil filters should at all times prevent particles larger than the bearing clearances from passing.

If smaller, micronic-size particles are permitted to circulate with the lubricant under conditions of cold starting and abnormal viscosity, and are eventually caught and trapped out, no harm will be done to the bearings. Particles 25 microns or less in size, for instance, will not at any time have any possible chance of being trapped in bearing clearances in conventional engines.

A relatively small diameter filter with a relatively high flow rate and a capacity for removing all material in sizes that would be injurious to bearing clearances, is the ideal filter. The Winslow filter unit shown in Fig. 1 removes all detrimental particle sizes by more or less mechanical straining in the high-flow-rate section of the filter. The soot particles and micronic-size particles recirculate through the slow-flow-rate section of the filter and are eventually removed by adsorption. The particles adhere to the leaves and fibers of the filter element material mainly because of the electrical charges between the surfaces. This process is further aided by catalytic and other action of chemicals in the material used in Winslow lubricating-oil and fuel-oil filters.

Certain of the chemicals aid filtering in much the same manner that detergents or soap compounds aid in a washing machine. Coalescence of moisture in lubricating oil is aided by other types of chemicals that are inert as far as the oil itself is concerned. All this is done without the removal of beneficial compounds which must be permitted to circulate continuously with the lubricant.

Filters should have adequate capacity so that surface-type filtration is avoided. The filter cartridge must begin its work by gradually building up dirt at the core and expanding with moisture, gum, asphaltum, and varnish. After expansion of the interior, the exterior portion, which has the greater volume, is brought into action. Finally the surface is sludged over and the cartridge is inoperative. (Paper "Filtration of Fuels and Lubricants for Internal Combustion Engines" was presented at SAE National West Coast Meeting, Aug. 14, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

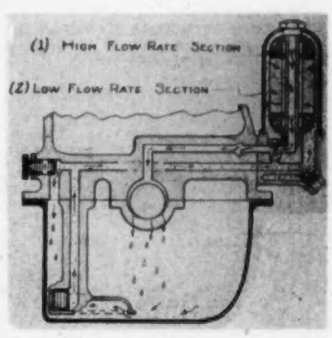


Fig. 1—Winslow dual-flow system of full-flow filtering

Convert Army Surplus Vehicle To High Capacity Dynamometer Truck

EXCERPTS FROM PAPER BY

W. C. Johnson, Goodyear Tire & Rubber Co.

• Paper, "The Goodyear Dynamometer Truck," was presented at the SAE National Tractor Meeting, Milwaukee, on Sept. 11, 1951.

GOODYEAR has had since 1937 a dynamometer truck of 5000 lb capacity for experimental work with farm tractor tires. During the past war the need became evident for a truck suitable to test larger tires such as those used on construction and road maintenance vehicles. Therefore, a larger dynamometer truck was built in 1946.

A measurement range of 40,000 lb of drawbar pull was selected, with a working maximum of about 35,000 lb. Plans also called for the truck to pull the vehicles under test to determine their drag, and for this purpose a maximum range of 20,000 lb was chosen.

A vehicle suitable for this application must inherently have good flotation so that it can operate on relatively soft soils and also have maximum tractive ability of its own. To meet these requirements, an all-wheel drive vehicle was the obvious solution. At the time, some Army trucks were declared surplus, and a 6-ton, 6×6 vehicle was selected as most nearly meeting our requirements.

The original cab had to be enlarged to provide seating capacity for observers and room for instruments. This required extending the rear of the frame and moving the body back, which allowed the body load to center somewhat behind the bogie—thereby lightening the load on the front axle. (A desirable feature as installation of the front pull-measuring equipment added considerably to the front axle load.)

Instrumentation was designed to enable the operator to compute the results as the test progresses.

Selection of a 6-wheel vehicle provided sufficient brakes so that they could be used as the source of energy absorption during the determination of drawbar pull of the vehicle being tested.

A water-ballast tank was installed in the center of the body. This permits increasing the gross weight of the vehicle to a maximum of about 41,000 lb, as compared to the un-ballasted weight of 28,000 lb. On a high friction surface, such as concrete, the truck can thus hold back unaided up to 24,000 lb. Where additional holdback is required, other vehicles or stone boats can be attached to a pintle at the rear of the truck.

Fig. 1 shows performance curves for the truck. Drawbar horsepower available averages slightly over 80 hp. Pulling ability varies from about 25,000 lb at 1 mph to under 1000 lb at 30 mph.

Tests results permit determining the combination of engine power, tire size, load, and pressure which will provide the most effective and economical performance under any operating condition.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

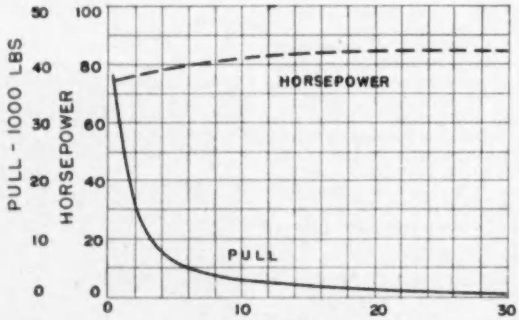


Fig. 1—Pulling ability of the Goodyear dynamometer truck varies from about 25,000 lb at 1 mph to under 1000 lb at 30 mph. Drawbar horsepower available averages slightly over 80 hp

Emphasizes Need for More and Better Planning

Excerpts from paper by

STEPHEN M. BATORI

Stephen Batori & Co.

MORE and better planning of freight terminal and maintenance facilities is needed before building, altering, or even buying land.

Of what does planning consist? Planning is an evaluation of the factors which influence the problem you are considering, giving due weight to each factor. Then, based on your findings, a scheme is established which puts as the primary consideration a composite of details that permit operating at highest capacity, consistent with lowest costs.

Planning should take into account management experiences, experiences of operating personnel, experiences of your industry, and the experiences of anybody who can help you with details which enter into the finished product.

During the planning state it is good policy to let competent unprejudiced persons review the facts and conclusions. Operating personnel are so close to everyday problems that they are prone to overlook improvements.

A word of caution now. It is advisable to use outside assistance during the planning stages. But be careful that you don't complete your plans without consulting your operating per-

sonnel. There are two very valid reasons for this: (1) operating personnel always have good ideas that won't occur to occur to others outside of your immediate circle, and (2) unless operating personnel have a hand in planning, they will feel slighted. And many things can go wrong during operations unless everyone is doing his best to make everything work properly, consciously or unconsciously.

A further requisite in planning is adequate use of available information, such as published for the industry by SAE and American Trucking Associations. Such information is general, of course, and must be adapted to each particular installation.

Finally, when you are ready to plan, take out the old crystal ball, polish it, say the magic words, and decide what the future will bring. Think of how you would handle twice as much business as you handle now, then consider how you would handle half as much. What changes in your plant would be necessary? How economically could you make changes?

Planning is a never ending task. You will not build or alter today and say, "That's finished. . . ." You must keep planning, because conditions change, and good practice today may be only mediocre tomorrow. (Paper, "Design Considerations When Planning Motor Vehicle Terminals and Shops," was presented at SAE Northwest Section Meeting on Jan. 5, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Streamlining Works Hardship on Radiators

Excerpts from paper by

J. R. HOLMES

Harrison Radiator Division, GMC

THE streamlining of automobiles has worked a real hardship on the engine radiator.

Fifteen years ago, we had radiators exposed to the air—without the disadvantage of grilles. Today, the grille in front of the radiator reduces the amount of air that is able to get through to the radiator.

In the past, we had louvers in the sides of the hoods which helped to vent the radiator outlet air. Now, air discharge from under the hood is restricted—all air must go down to the roadway.

Present day ventilating systems have the habit of taking air from the compartment between the grille and radiator. This tends to reduce the pressure in this area; therefore, the amount of air available to the radiator. To design a radiator for such minimum airflow, a greater temperature rise must be used to complete the heat balance of the air and water circuits.

Another outgrowth of streamlining is the difficulty of properly sealing the space between the radiator and the front grille from the space behind the radiator. In many cases, parts do not fit properly and air is lost between the two compartments without going through the radiator. (Paper, "Automotive Cooling," was presented at SAE Mid-Michigan Section Meeting on Sept 18, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Cylinder Materials Need More Attention

Excerpts from paper by

A. M. BRENNEKE

and

A. J. WEIGAND

Perfect Circle Corp.

CYLINDER materials are an item of design which have been overly neglected. Few engine builders have gone farther than to specify hardness and chemical composition. The more vital factors of microstructure and physical properties are seldom covered at all. The intense activity in engine development and the concentration of operators on reducing maintenance costs in the postwar period has stimulated considerable progress in this field.

The most important factor in a cylinder material is its structure. Graphite is probably the most important constituent in cast iron which is intended to serve as a bearing. A graphite structure of a random type (Flake Size No. 5 or 6, Type A and B) is almost universally accepted as a standard requirement for cylinder material. (See Fig. 1.) Large amounts of cementite and massive carbides are considered undesirable.

Centrifugal cast liners are generally preferred for uniformity and freedom from defects. However, completely satisfactory structures and high quality cylinder material can be produced either by the centrifugal process or by static casting in sand molds. The centrifugal casting technique must be such as to insure a cooling rate comparable with that of sand casting. And the casting—as it comes from the mold—must be entirely free of chill and fully machinable.

Considerable reduction in cylinder wear and ring wear can be attributed to the increasing trend toward use of fully hardened cylinder liners of the wet or dry type. The fully hardened liner is usually in the range of 450 to 550 Brinell hardness. It is definitely preferred over the as-cast liner in the 200 to 300 Brinell range—primarily for its greater resistance to abrasive wear.

Abrasive wear is probably the largest contributor to the overall wear problem. Economics of the situation generally dictate the choice between fully hardened and as-cast liners.

(Paper "Piston Rings and the Wear Problem," was presented at SAE National West Coast Meeting, Seattle, Aug. 13, 1951. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

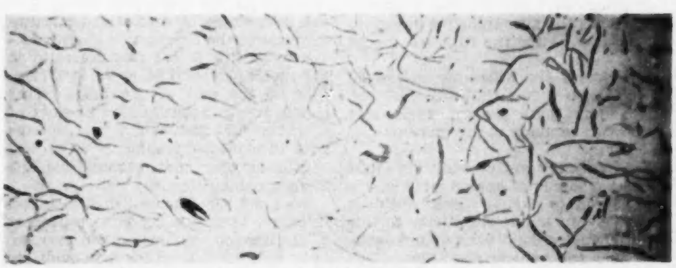


Fig. 1 — A random type graphite structure (Flake Size No. 5 or 6, Type A and B) is almost universally accepted as a standard requirement for cylinder material

Mechanical Octanes Could Conserve Fuel

Excerpts from paper by

ALEX TAUB

Taub Engineering Co.

TO balance supply and demand for petroleum fuels we must use less fuel per vehicle in miles per gallon, as well as extract more motor fuel from each barrel of crude, and more total fuel per year.

Decreasing the fuel used per unit means engines must require less fuel, and increasing the fuel supply means engines must use medium- and low-octane fuel. Together these points represent the heart of the problem, a problem that must be resolved by means other than producing new engines that require fuel not likely to be available. The answer must be new engines that will burn less fuel per unit of a type of fuel most easily produced—and that means a fuel between 65 to 80 octane, with the bulk of this on the low side.

Since a basic part of this problem is to lower unit fuel consumption, all contenders for leadership in engine design agree that a major objective must be higher-compression-ratio engines. The increase in compression ratio must be sufficient to provide us with a 40% improvement in fuel usage.

Detonation is the limiting factor of high compression. We may avoid detonation by chemical means through the fuel characteristics. Or we may do it thermally by (1) absorption of the heat generated in the last portion of fuel in the chamber to burn, (2) lowering the overall temperature of the burning mixture so that the last portion of gas to burn cannot explode, (3) stratifying the mixture so that there is insufficient fuel in the last gas to support a rapid burn or (4) providing a means for withholding the fuel from the combustion chamber until the exact moment it is required for burning, under which conditions there would be no time for the pressure and heat to "process" the fuel for detonation.

If the public could set down what it needs from the auto industry in engine characteristics for the future it might say:

1. Increase the miles per gallon 30 to 40% with a fuel that will cost less per gallon than present fuels and which can be made in any present-day refinery.

2. Eliminate costly additives that may be a source of engine trouble.

3. Eliminate vapor lock troubles caused by an undue sensitivity to this fault by engine conditions with reasonable fuel and vehicle operation.

4. Eliminate complex engine manifolds and heaters that are hot in the summer and cold in the winter. These changes should eliminate the need for vaporization of the fuel outside of the engine.

5. Eliminate the lean and rich variation among cylinders caused by poor mixture distribution. The intake manifold should carry only air — not gasoline. If after 35 years, wet mixtures cannot be manifolded, then get rid of the wet mixtures.

6. Use fuel injection to eliminate the carburetor and have available the effect of priming equally in all cylinders for any kind of hot or cold starting.

7. Approach constant compression by throttling the fuel alone, instead of a fuel-and-air mixture. This should give a substantial improvement in road-load fuel consumption and eliminate the extra fuel normally required for acceleration since the precipitation of fuel in the manifold when the throttle is opened would be eliminated.

8. Use fuel injection to give automatic correction for conditions from sea level to mountain top. Present-day vehicle carburetors give a correct air/fuel ratio at one condition of altitude only and, except for the automatic choke, have one set of mixture ratios winter and summer. Injection, in effect, changes jets continuously as required since the fuel supply increases and decreases according to the demand of changing conditions.

New engines could be based on a new philosophy: non-detonation would be sought without regard to high octane fuel. One step would be to eliminate all heat to the air before it enters the combustion chamber, bearing in mind that every degree F means nearly 50 F at the detonating or exploding area. Another step could be the elimination of all internal hot spots in the combustion chamber such as the exhaust valve, piston head, and local hot-spots in the cylinder head wall. These two steps should be supplemented with the usual and presently used precautionary tricks of eliminating application of full torque below 1600 rpm with a slipping coupling between engine and transmission, and, of course, a retarded spark.

Another method to extend our outlook on non-detonating engines without special regard to fuel would be to inject fuel directly into the combustion chamber at the spark-plug area. The objective would be a stratified mixture throughout the combustion chamber — approximating 9 to 1 mixture ratio at the spark plug and 21 or 25 to 1 mixture at the end of the burn. This should supply good ignition at start of the burn and insufficient fuel to support an explosive action.

Still another means would be the Texaco combustion process.

We must bear in mind that with fuel injection (which is an important part of the Texaco combustion process), we have no critical need for light ends for starting. We may not need tetraethyl lead as an additive for antidetonation. We could expect more consideration for the elimination of gum and other residues that our engines convert to carbon and other sticking solids; and, perhaps, we may look forward to an anticorrosive fuel that would protect the cylinder bores.

Heretofore, improvement in "mechanical octanes" has been sought through the reduction of the final temperature of the end gas by (1) reducing the air temperature from carburetor inlet to the time of ignition; (2) providing greater surface-to-volume ratio at the area of the end gas which absorbs the excess heat created in the unburnt gas by pressure and radiation; and (3) lowering the heat pick-up of the mixture within the combustion chamber during induction and compression through decreasing the temperature of hot areas in the chamber such as the exhaust valve, piston head, and local poorly cooled areas.

We perhaps may now deal directly with the temperature and quality of the end gas for the benefit of "mechanical octanes." If there is insufficient fuel in or time for the last gas to burn to support an explosive burn, then we cannot have detonation.

In engines with fuel injection there need be no fuel in the chamber until almost time for ignition, and most of the fuel can be forced into the chamber after ignition. This precludes preignition.

We are certain that many rewards in the form of additional mechanical octanes await the engine designer willing to investigate the quality as well as the temperature of the end gas. (Paper "Mechanical Octanes" was presented at the SAE Chicago Section meeting, May 8, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Heavy-Duty Lubricant Designations Multiply

Excerpts from paper by

L. F. MOCK, JR.

Staff Automotive Engineer, Gulf Oil Corp.

MANY different specifications for so-called heavy-duty or detergent motor oils have been used during the past 10 years.

One of the first such specifications was U. S. Army Specification 2-104B, which is sometimes mentioned today although it has been obsolete for almost two years.

Advent of certain new engines, more severe service conditions, and higher-sulfur fuels led the Ordnance Depart-

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TECHNICAL COMMITTEE *Progress*

Report on How to Predict Truck Ability Is Published

TRUCK Ability Prediction Procedure (Sp-82)— a report for which an SAE committee has been collecting data for five years—has been completed and published.

The report provides tabulated and charted data on rolling resistance, air resistance, and chassis friction for calculating:

1. Performance obtainable from a truck of given characteristics under given operating conditions.
2. Characteristics required in a truck to meet different performance requirements under given operating conditions.

Besides the data, the report includes an explanation of the calculation procedure, facsimiles of a work sheet and the SAE Commercial Vehicle Ability Report, an example worked in detail to illustrate the method, and a discussion of the reliability of the predictions.

A condensation of the report—including the charts, tables, and facsimiles—has been approved as the SAE Recommended Practice on Truck Ability Prediction Procedure and will appear in the 1952 SAE Handbook.

The complete report is available from the SAE Special Publications Division at $1.50 to SAE members and $3.00 to nonmembers. Work sheets are available in pads of 150 for $2.00 per pad to members and $4.00 per pad to nonmembers. One copy of the SAE Commercial Vehicle Ability Report is supplied with each pad. Additional copies are priced at 25¢ each for 2 to 9 copies, 10¢ each for 10 to 49 copies, 5¢ each for 50 to 99 copies, and 2¢ each for 100 or more copies.

The prediction procedure was developed by the Subcommittee on Classification and Evaluation of Transportation Engineering Formulas of the SAE Transportation and Maintenance Technical Committee. F. B. Lautzenhiser is chairman of the Subcommittee, and Merrill C. Horine is chairman of the Subcommittee's editorial group, which drew up the publications.

Engine, Propeller Men Form New Joint Panel

STANDARDIZATION of propeller attachments for advanced powerplants is the goal of a new joint panel of Aircraft Engine Division Committee E-21 and Aircraft Propeller Division Committee P-6.

At the panel's initial meeting, on November 27, members agreed to consider first the development of a standard based on the design tentatively established by a joint panel of the Aircraft Industries Association (Aeroproducts drawings L-30020 and L-16968). Then any other proposals received will be considered.

The panel approved this tentative program for its work:

1. Develop estimates of the minimum and maximum values for the bolt circle diameter shown on the AIA drawings. These will be based on the extremes of gear case size dictated by the range of powers and speeds given on the drawings. In considering the effects of propeller load, a maximum precession rate of 2½ radians per sec will be used.
2. Attempt to classify diameters determined in Item 1 into appropriate sizes—that is, similar to various spline sizes now being used on propeller shafts.
3. Review force and moment considerations to determine if they will have any influence on the diameters selected. (Propeller engineers present felt that the diameters dictated by engine gear cases will be sufficient to carry the loads imposed by the propeller.)
4. Consider methods of attaching the device to the engine—that is, such fasteners as studs, bolts, and quick-attach-detach devices.
5. Detail the design selected.
6. Investigate the spline required to carry the load. Consideration is to be given to establishing satisfactory lengths and diameters of the spline, the degree of looseness required for assembly, protection, and lubrication of the spline, and the sealing required to keep the lubrication in the propeller unit.
7. Develop a standard drawing giving detail information concerning the combination of spline and mounting configuration for the range of characteristics called out on the AIA drawing.
8. Consider the provision of accessible areas or volumes for servicing propeller controls.

Panel members verified the need for a 3-in. clearance hole through the propeller and attachment device. They agreed also that—at least for the present—they will plan on use of capscrews for attaching the propeller to the engine.

Next meeting of the panel will be held on Tuesday, January 8, in New York. Panel members include: W. E. Diefenderfer, chairman; M. E. Cushman; E. Heaton; K. E. Fransson; D. R. Pearl; V. W. Peterson; N. F. Rooke; R. F. Schwarzwalder; and G. R. Taylor.

Standard Test Rig for Pulsation Testing on Way

WORK on a proposed standard test rig for pressure pulsation testing of aircraft hydraulic pumps is nearly completed. All components of the test set-up, with the exception of the cut-off valve, have been defined by Committee A-1, Aircraft Pumps of the SAE Aircraft Accessories and Equipment Division.

A survey of requirements suggested that this function could best be carried out by a hydraulic cylinder rather than a solenoid-operated valve. The Committee is now determining the characteristics of cylinders to be used in the test set-up. Initial design work on the cylinders is being based on a cut-off time of 0.05 sec, which seems to be consistent with values that are obtained in aircraft hydraulic systems.

When completed, the test rig—used to test the ability of hydraulic pumps to compensate for rapid changes in pump output—is expected to enable manfuacturers to obtain reproducible results in pulsation test work; something which has hitherto been lacking.

The above work will assist the Committee in developing realistic pressure pulsation requirements for incorporation in present pump specifications.

C. L. Sadler of Sundstrand Machine Tool is sponsoring and guiding this project to completion.

Acoustical Materials Specification Approved

A NEW SAE Recommended Practice for sound deadeners and underbody coatings has been approved by the SAE Technical Board for publication in the 1952 SAE Handbook.

Prepared by a joint subcommittee of the SAE Non-Metallic Materials and SAE Passenger Car Body Engineering Committees, this Recommended Practice treats with: (1) mastic sound deadeners used to reduce the sound emanating from metal panels, and (2) mastic underbody coatings used to give protection—and some sound deadening—to motor vehicle underbodies, fenders, and other parts.

Specifications are given for the physical properties and method of testing these materials. A special numbering system indicates whether materials are cutbacks or water emulsions. Materials are further classified into types, based on the decay rates, and classes, based on the percentage of solids contained in the material.

Chairman of the subcommittee that developed this specification was L. M. Ball of Chrysler Corp. Serving with him on the subcommittee were H. Beckerley, General Motors; L. H. Frailing, Packard; J. T. O'Reilly, Ford; and J. P. Wilson, Ford.

Packaging Standards Under Reconsideration

REVISION or cancellation of SAE's standards and specifications on preservation and packaging of aeronautical parts and equipment is under consideration.

The SAE Aeronautics Committee has directed that possible users of the standards and specifications be asked:

1. Which, if any, of SAE's preservation and packaging documents does your company use?
2. Would the cancellation of these documents cause difficulty in the procurement or production activities of your company?

Such a questionnaire has been sent to airplane manufacturers, aircraft engine manufacturers, airline operators, members of all SAE Aeronautics Committee divisions, and members of all committees operating under the Aeronautic Committee's Accessories and Equipment Division. Replies to the questions are welcome from other interested parties also.

If the replies warrant it, the Aeronautics Committee may reactivate Committee S-6, Preservation and Packaging of Aeronautical Parts and Equipment to bring the documents up to date; otherwise, the Aeronautics Committee may cancel them.

Approve Standard for Tractor Remote Controls

A NEW SAE Standard covering the application of hydraulic remote controls to farm tractor and trailing-type farm implements has been approved by the SAE Technical Board on recommendation by the Tractor Technical Committee. Prepared by the Farm Equipment Institute, this Standard has also received the approval of the American Society of Agricultural Engineers. It will be published in the 1952 SAE Handbook.

Overall aim of the Standard is to establish common mounting and clearance dimensions for hydraulic control cylinders and the trailing-type implements on which they are mounted. Specific objectives are:

- To permit use of any make or model of trailing-type farm implement —adapted for control by an 8-in. stroke hydraulic cylinder—with the 8-in. hydraulic cylinder furnished with any make or model of farm tractor.
- To permit use of any make or model of trailing-type farm implement —adapted for control by a 16-in. control cylinder—with the 16-in. stroke hydraulic cylinder furnished with any make or model of farm tractor.
- To facilitate changing the hydraulic cylinder from one implement to another.
- To decrease the possibility of introducing dirt or other foreign material into the hydraulic system—by reducing the necessity for supplemental hose lengths or piping with certain types of equipment.

The Standard does not cover hydraulic controls for tractors having a work capacity over 20,000 lb maximum drawbar pull. Most implements for use with such tractors are regularly provided with one or more suitable cylinders and, therefore, impose very little requirement for interchangeable use of control cylinders.

Prepare Terminology Of Turbine Powerplants

DEFINITIONS of additional terms applying to gas turbine powerplants are being drafted for inclusion to ARP 341A, Nomenclature Guide for Aircraft Engine Parts. The work is being done by Committee E-21 of the SAE Aeronautics Committee's Aircraft Engine Division.

Definitions under consideration include:

"**Afterburner**—a device in which exhaust gases are reheated to give additional thrust."

"**Glowplug**—a unit which includes a surface which can be heated to produce sustained or continuous ignition of the combustible mixture in a combustion chamber."

"**Torchigniter**—an arrangement or assembly used to blow or project a flame into a combustible mixture to start combustion."

"**Regulator**—any device or assembly which automatically regulates or adjusts one or more conditions from another condition or set of conditions."

Also under consideration are revisions to the current definitions of "carrier," "flameholder," and "spark torchigniter."

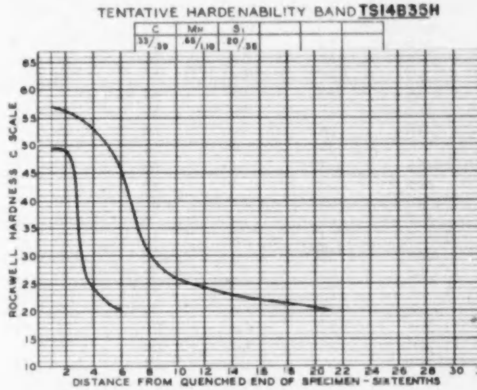
AISI Publishes H-Bands for 5 Boron Steels and Chemical Composition Limits of 14 New and Revised Grades

HARDENABILITY-band limits for five boron steels and chemical composition ranges for 14 new and revised steel grades were published by the American Iron and Steel Institute under date of December, 1951. These bands and chemistries are the result of joint effort by the AISI and the SAE Iron and Steel Technical Committee.

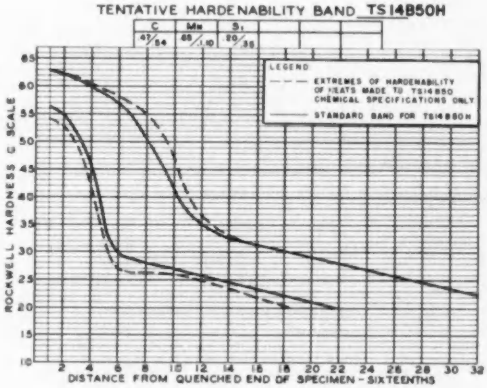
The hardenability data are for the five steels TS 14B35 H, TS 14B50 H, TS 50B46 H, TS 86B45 H, and TS 94B17 H. The data are reproduced in the accompanying charts and in Table 1. Tabulated values have been adjusted to the nearest Rockwell C unit

Continued on Page 77

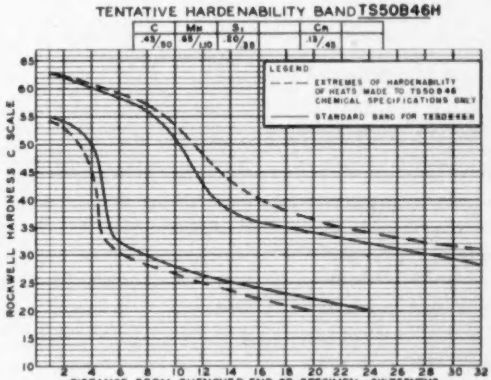
TENTATIVE HARDENABILITY BAND TS14B35H



TENTATIVE HARDENABILITY BAND TS14B50H



TENTATIVE HARDENABILITY BAND TS50B46H



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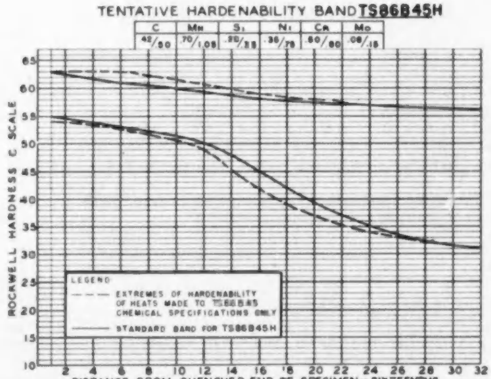


TENTATIVE HARDENABILITY BAND TS94B17H

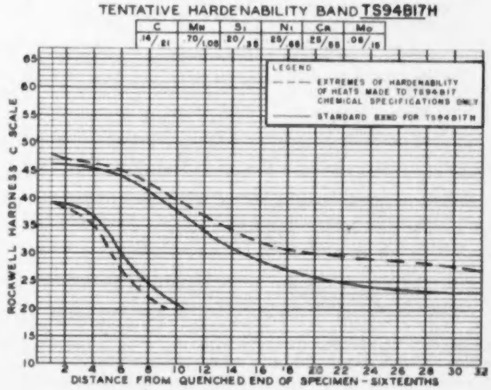


Table 1—End-Quench Hardenability Bands for TS 14B35 H, TS 14B50 H, TS 50B46 H, TS 86B45 H, and TS 94B17 H

"J" Distance Inches	Grade									
	TS 14B35 H		TS 14B50 H		TS 50B46 H		TS 86B45 H		TS 94B17 H	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1/16	57	49	63	56	63	55	63	55	46	39
1/8	56	49	62	55	62	54	63	55	46	39
3/16	55	31	61	51	61	52	62	54	46	38
1/4	53	24	60	46	60	50	62	54	45	37
5/16	50	22	59	35	59	41	61	53	45	34
3/8	45	20	57	30	58	32	61	53	44	30
7/16	36	—	54	29	57	31	61	52	43	27
1/2	30	—	51	28	56	30	60	52	41	24
9/16	27	—	46	27	54	29	60	51	40	22
5/8	26	—	41	27	51	28	60	51	38	21
11/16	25	—	37	26	47	27	59	50	36	—
3/4	24	—	35	26	43	26	59	50	34	—
13/16	24	—	34	25	40	26	59	49	32	—
7/8	23	—	33	25	38	25	59	48	31	—
15/16	23	—	32	24	37	25	58	46	30	—
1	22	—	31	23	36	24	58	45	29	—
1-1/8	21	—	30	22	35	23	58	42	27	—
1-1/4	20	—	29	21	34	22	58	39	26	—
1-3/8	—	—	28	20	33	21	57	37	25	—
1-1/2	—	—	27	—	32	20	57	35	24	—
1-5/8	—	—	26	—	31	—	57	34	24	—
1-3/4	—	—	25	—	30	—	57	32	23	—
1-7/8	—	—	24	—	29	—	56	32	23	—
2	—	—	23	—	28	—	56	31	23	—

Table 2—New and Revised Grades

Status	Chemical Composition Limits, per cent							
	Grade	C	Mn	Si	Ni	Cr	Mo	V
New SAE and AISI Standard Grades	4118	0.18/0.23	0.70/0.90	0.20/0.35	....	0.40/0.60	0.08/0.15	....
	5155	0.50/0.60	0.70/0.90	0.20/0.35	....	0.70/0.90	....	....
New AISI Tentative Standard Grades	TS 4613	0.10/0.15	0.45/0.65	0.20/0.35	1.65/2.00	....	0.25/0.35	....
	TS 4618	0.15/0.20	0.45/0.65	0.20/0.35	1.65/2.00	....	0.25/0.35	....
New AISI Tentative Standard Boron Grades	TS 46B12	0.10/0.15	0.45/0.65	0.20/0.35	1.65/2.00	....	0.20/0.30	....
Revised AISI Tentative Standard Boron-plus-Vanadium Grades	TS 43BV12	0.08/0.13	0.75/1.00	0.20/0.40	1.65/2.00	0.40/0.60	0.20/0.30	0.03 min.
	TS 43BV14	0.10/0.15	0.45/0.65	0.20/0.35	1.65/2.00	0.40/0.60	0.08/0.15	0.03 min.
AISI Tentative Standard Grades Previously Published without "TS" and with Wider Ranges	TS 14B35	0.33/0.38	0.75/1.00	0.20/0.35	....	....	....	....
	TS 14B50	0.48/0.53	0.75/1.00	0.20/0.35	....	....	....	....
	TS 40B37	0.35/0.40	0.70/0.90	0.20/0.35	....	....	0.08/0.15	....
	TS 50B50	0.48/0.53	0.75/1.00	0.20/0.35	....	0.40/0.60	....	....
	TS 50B60	0.55/0.65	0.75/1.00	0.20/0.35	....	0.40/0.60	....	....
	TS 80B37	0.35/0.40	0.75/1.00	0.20/0.35	0.20/0.40	0.20/0.35	0.08/0.15	....
	TS 81B40	0.38/0.43	0.75/1.00	0.20/0.35	0.20/0.40	0.35/0.55	0.08/0.15	....

Note 1. Steels with a "B" in their designation can be expected to have 0.0005% minimum boron content.

Note 2. The phosphorus and sulfur limitations for each steel making process are as follows:

Basic electric furnace—0.025% max
Basic open hearth —0.04% max
Acid electric furnace —0.05% max
Acid open hearth —0.05% max

Note 3. Minimum silicon limit for acid open hearth or acid electric furnace alloy steel is 0.15%.

Note 4. Small quantities of certain elements are present in alloy steels which are not specified or required. These elements are considered as incidental and may be present to the following maximum amounts: copper, 0.35%; nickel, 0.25%; chromium, 0.20% and molybdenum, 0.06%.

Continued from Page 75

and are to be used when points are selected and specified.

Chemistries

The 14 new and revised compositions are given in Table 2.

• Two of the new grades are the SAE standard steels SAE 4118 and SAE 5155 just approved by the SAE Technical Board. SAE 4118 contains 0.08-0.15% molybdenum, and SAE 5155 contains none. Neither steel contains nickel. Both grades will appear in the 1952 SAE Handbook.

The other new and revised steels are AISI Tentative Standard steels developed to conserve nickel and molybdenum.

• TS 4613 and TS 4618 are new grades intended for oil-well drilling equipment such as rock bit cutters.

• TS 46B12 is a new boron steel also intended as an alternate to the SAE 48XX grades for oil-well drilling equipment.

• TS 43BV12 and TS 43BV14 have been revised since their original publication as Tentative Standards on June 13, 1951. For TS 43BV12, limits are now 0.08-0.13% carbon instead of 0.09-0.14%, and 0.20-0.40% silicon instead of 0.20-0.35%. For TS 43BV14, limits are now 0.45-0.65% manganese instead of 0.75-1.00%, and 0.08-0.15% molybdenum instead of 0.20-0.30%.

TS 43BV12 is intended as an alternate to the SAE 33XX and SAE 93XX grades for aircraft engine parts. TS 43BV14 is intended as an alternate to the SAE 33XX, SAE 48XX, and SAE 93XX grades for heavy-duty truck parts.

• The other seven newly published Tentative Standard grades are TS 14B35, TS 14B50, TS 40B37, TS 50B50, TS 50B60, TS 80B37, and TS 81B40. These are grades whose numbers—without the "TS" prefix and with wider chemical ranges—were published previously by AISI as supplementary information.

Copies Available

The hardenability-band tabulation for the H-band boron steels and the chemical composition ranges for the other 14 steels are available in pamphlets headed "Supplementary Information, December 1951" from the American Iron and Steel Institute, 350 Fifth Avenue, New York, as revisions to AISI Steel Products Manual Sections 10, 28, and 29. The hardenability charts are also available from AISI as a revision to No. 11 of the "Contributions to the Metallurgy of Steel" series.

Techniskets . . .

VIBRATION DATA—Urgent need for more information on linear and torsional vibration of aircraft engines prompted Committee AE-1, Joint Aircraft Engine and Accessory Installations of the Aircraft Accessories and Equipment Division, to form a new panel. This panel has been, and is, gathering together all such available vibration data and plans to put it in the form of an Aeronautical Information Report. Serving on the panel with Chairman E. G. Emery, Jr., of Pratt & Whitney are H. D. Else, Westinghouse; C. S. Metsger, Bendix; and I. Kalikow, General Electric.

BEARING OVERLAY MATERIAL—Addition of an "overlay material for application to copper-lead alloys such as SAE 49" to the SAE Standard on Main and Connecting-Rod Bearing Alloys is under consideration by the Bearing and Bushing Alloys Subcommittee of the SAE Nonferrous Metals Technical Committee. Proposed composition is 8-12% tin, 1.5-3% copper, and the remainder lead. Even if this becomes an SAE standard composition, tin content will, of course, have to be held down to 10% as long as the present tin order is in effect.

UNIFIED THREADS USAGE—To facilitate use of Unified threads throughout the aeronautic industry, Committee S-1 (the Aeronautical Drafting Manual Committee of the SAE Aeronautics Committee's Special Aircraft Projects Division) recently opened a project to prepare manual pages outlining usage and call-out methods for Unified threads on drawings. Also, a decision to use Unified thread series on all its new standards for aircraft engine and propeller utility parts has been made by Committee E-25 of the Aircraft Engine Division.

CIRCUIT BREAKERS—An SAE Recommended Practice for Circuit Breakers has just been approved. It covers current and voltage rating, life testing, opening and closing temperatures, maximum effective value of current passed on overload, and dimensions. The recommendation was developed by the SAE Electrical Equipment Committee's Circuit Breaker Subcommittee under the leadership of E. F. Webb, chairman.

USAGE SURVEY OF E-25 STANDARDS—J. D. Clark announces an annual usage survey is to be made of all aircraft engine and propeller utility-parts standards prepared by Committee E-25 of the SAE Aeronautics Committee's Aircraft Engine Division. This includes E-25-prepared Military Standards (AN and MS) as well as E-25's SAE Aeronautical Specifications (AS). Results of the surveys will help E-25 decide which documents need revision or cancellation. The first annual survey will soon be under way. Similar annual surveys are made regularly for Aeronautical Materials Specifications (AMS).

EIGHT FRENCH ENGINEERS visited SAE headquarters recently to learn about some of the details of the Society's standardization activities. The visit was part of a five-week tour the Frenchmen are making to survey American experience in use of cooperative standards, industrial specialization, and factory simplification. Their tour was arranged by the National Management Council under the productivity and technical assistance program of the Economic Cooperation Administration. The group was sponsored by the French National Standards Association (AFNOR).

At the beginning of their tour, the visitors were feted at a luncheon with representatives of the American Standards Association, American Society of Mechanical Engineers, and SAE at the Engineers Club in New York.

CHARLES D. McCALL has been appointed general sales manager of the New Departure Division of General Motors Corp. McCall has been with General Motors since 1931, for the past 3 years as manager of New Departure's central regional office in Detroit. He succeeds **FRANK J. MILLER**, who has retired from the company for reasons of health after 33 years of service.

JOHN R. ROSE has been promoted to sales manager of the automotive equipment division of Wagner Electric Corp. Rose has been with Wagner since 1919. He was previously manager of the automotive parts division, and most recently has been assistant sales manager of the automotive equipment division.

DR. WILLIAM A. GRUSE, administrative fellow of the Petroleum Refining Fellowship of Mellon Institute, was presented with the Pittsburgh Award for outstanding service to chemistry on Dec. 10. The award, presented by the Pittsburgh Section of the American Chemical Society, recognizes the advances made under Dr. Gruse's direction in the chemistry of refining petroleum.

DUFF L. DEAN has been named head of the Johns-Manville Sales Corp. aviation department in the Southern California area. Dean will be working on the solution of heat insulating problems, and will serve as liaison between airframe companies and the new Johns-Manville Research Center in Manville, N. J. Dean has previously been associated with Lord Mfg. Co. and Pacific Airmotive Corp.

JOHN OSWALD is now vice-president of Allen, Anderson, Oswald and Co., Inc., in Birmingham, Mich. He was previously associated with Ford Motor Company's engineering laboratory. Oswald was SAE vice-president representing passenger car body engineering in 1940.

GENE T. NEUDECK has been named sales manager of the automotive and aeronautical products division of Young Radiator Co., Racine, Wis. A 1941 graduate of the University of Michigan, Neudeck spent 10 years as sales engineer with the aero-products division of General Motors Corp., and was recently associated with V. L. Graf Co., Romeo, Mich., as sales manager.

About

DR. FLOYD L. MILLER, succeeds **DR. ROBERT C. GUNNESS** as vice-chairman of the Research and Development Board of the Defense Department in Washington, D. C. Dr. Miller has been director of the research division of the Esso Laboratories since 1947. He joined Standard in 1930 as a research chemist for Standard Oil Development Co.

HOWARD J. GRANINGER has been named representative in Washington, D. C., for Wright Aeronautical Division of Curtiss-Wright Corp. Graninger has been associated with Wright since graduating from Virginia Polytechnic Institute in 1941, except for two years with the Air Corps. He has most recently been assigned to the sales department.

WENDELL E. FAULK is now consultant to Pacific Tire and Rubber Co., Oakland, Calif. He was formerly manager of development, sales and engineering, for U. S. Rubber Co. in Chicago.

ALBERT E. MANSFIELD, JR., is now superintendent of maintenance for Brown Express in Dallas, Texas. He was formerly shop foreman of Aetna Auto Parts Co., Chicago, Ill.

WALTER A. WORON, who was editor of Motor Trend magazine, has been promoted to editorial director of Trend, Inc., Los Angeles, Calif., publishers of automotive periodicals.

THOMAS J. HUTCHISON, JR., is now technical engineer with Standard Steel Spring Co., Newton Falls, Ohio. Hutchison was previously general manager of Steel Shot Producers, Inc., Butler, Pa.

JOHN E. FRAZER has joined the ordnance division of Food Machinery and Chemical Corp., San Jose, Calif., as assistant manager of the quality control department. He was formerly assistant chief of the manufacturing inspection branch of Civil Aeronautics Administration's region 3 in Chicago.

Members

ROBERT P. GILMARTIN has been named chief fuels and lubricants engineer, equipment section, of Gulf Oil Corp., Pittsburgh, Pa. Gilmartin will also have responsibilities on sales technical services on home heating oils. He was previously head of the fuels group in Gulf's chemical division.

DAVID M. LITTLE is chief industrial engineer for Roddis Plywood Corp., Marshfield, Wis. He was formerly with Josten Mfg. Co. in Owatonna, Minn., as chief industrial engineer and general counsel.

JOHN S. CONANT has been named European manager of Mead, Carney and Co., of New York. Conant, who was formerly president of Technical Managers, Inc., will have headquarters in London.

WILLIAM L. BATT, minister in charge of the Economic Cooperation Administration Mission to the United Kingdom, was honored at the Annual Meeting of the American Society of Mechanical Engineers. Batt was awarded the Hoover Medal for 1951 in recognition of his "leadership in engineering, management and public responsibility." The medal is a joint award of ASME, American Institute of Mining and Metallurgical Engineers, American Society of Civil Engineers, and American Institute of Electrical Engineers. Batt, who for 28 years was head of SKF Industries, has served the government in many capacities, including vice-chairman of the War Production Board during World War II.

DONALD G. DEAN has joined Booz, Allen and Hamilton, management consultants, Chicago, Ill. He was previously associated with Ford Motor Co. as supervisor of planning and scheduling.

HAMILTON S. SHERWOOD, who was formerly with McCann Erickson, Inc., is now sales supervisor of the tractor division of Swan-Finch Oil Corp., New York, N. Y.

RICHARD H. LONG has been named assistant chief engineer of the automotive section of Bendix Products Division, South Bend, Ind. Long joined Bendix in 1939 as a laboratory technician and has been assigned to development engineering for the past 5 years.

WILLIAM W. HIGGINBOTHAM has joined Southwest Research Institute, San Antonio, Texas, as resident engineer. He was formerly experimental test engineer for Hudson Motor Car Co. in Detroit.

JOHN T. PARKS has joined Curtis Industries, Inc., of Cleveland, as director of purchasing. Parks was previously head of the engineering department of Bowman Products Co., also in Cleveland.

GEORGE T. HAYES has joined the business and industrial economics department of Stanford Research Institute, Stanford, Calif. Hayes was previously staff engineer with American Airlines, Inc., in New York.

WILLIAM K. TOBOLDT, editor of Motor Service magazine, is the coauthor of a new book entitled Automatic Transmissions, a handbook on the theory and servicing of self-operating transmissions, published by Laurel Publishers, Scranton, Pa.

KAY I. NAGAGIRI is now a design engineer with Lockheed Aircraft Corp., Burbank, Calif. Nagagiri, who was formerly with Heil Co. in Milwaukee, is working on the layout of hydraulic systems for the Lockheed Constellation.

ROBERT H. GARMEZY is now with Blackstone Corp., Jamestown, N. Y. Garmezy was formerly in the electrical department of Chrysler's Central Engineering, Highland Park, Mich.

HARVEY J. HINCKER has been named chief engineer of the automatic department of Automatic Transportation Co., Chicago. Hincker was previously supervisor of design and research for the materials handling division of the Buda Co., and earlier was a draftsman for Automatic. During World War II he served as an Army Air Force navigator for 3 years.

JAMES R. THOMPSON, manager of the metallurgical department of American Steel and Wire Co., Cleveland, retired on Nov. 30 after a half-century with the company. Thompson joined the wire company in 1901 as a chemist at Newburgh Steel Works, and served in many capacities before being named manager of the metallurgical department in 1942. He is a member of the general technical committee of the American Iron and Steel Institute and chairman of the rod and wire committee.

DANIEL L. WERTZ has been named vice-president in charge of sales of Dow Furnace Co., Detroit. Wertz joined Dow in 1948 as sales representative for the midwest after many years in the sales and engineering departments of Bendix Aviation Corp.

Ford Engineering Staff Appointments


V. Y. Tallberg


R. F. Kohr

Creation of three new executive offices on the engineering staff of Ford Motor Co. has been announced by **HAROLD T. YOUNGREN**, vice-president in charge of engineering. **V. Y. TALLBERG** has been named executive engineer, administration. **R. F. KOHR** becomes executive engineer, general engineering. An executive engineer, passenger vehicles, will be named at a later date. **DALE ROEDER** continues as executive engineer, commercial vehicles.

A five-man engineering board for formulating staff policy and programs will be headed by **E. S. MacPHERSON**, chief engineer, engineering staff. **H. D. ALLEE**, manager of the engineering programming department, was named secretary to the board.

Six new department heads have been named on the engineering staff. **H. F. COPP** will direct the military vehicle department, replacing **N. L. BLUME**, who has been named to head the Lincoln-Mercury car engineering department. **H. H. GILBERT**, who formerly held the Lincoln-Mercury post, has been appointed head of the testing laboratory department. **H. A. MATTHIAS** will direct the special vehicle development department and **H. G. ENGLISH** will head the transmission department. **A. M. WAUTERS** replaces Kohr as head of the engineering research department.


N. L. Blume


H. H. Gilbert


H. G. English


A. M. Wauters

CORNELL JANEWAY is now assistant chief of design for Taub Engineering Co., Washington, D. C. Janeway was previously with Reo Motors, Lansing, Mich.

R. M. HEMPEL is now with the Armour Research Foundation of the Illinois Institute of Technology, Chicago, as assistant engineer. He was formerly with McDonnell Aircraft Corp. in St. Louis, Mo.

LEWIS R. CATT has been recalled to the U. S. Navy and is serving with Bureau of Supplies and Accounts in Washington, D. C., on the formulation and coordination of technical specifications for Navy mechanized material handling equipment. Before returning to the Navy, Catt was with Ohio Farm Bureau Cooperative, Columbus, Ohio.

ROBERT J. NEUBACHER, who was assistant ring engineer for Burd Piston Ring Co., Rockford, Ill., has been recalled to the Army. Lt. Neubacher is on overseas duty in Europe.

M. ROBERT SKROKOV, who was formerly development engineer for Caltex Oil Co., Ltd., in New York City, has joined Taylor Instrument Co., Rochester, N. Y., as instrument sales and application engineer. Skrokov will be at the company's home office in Rochester for the next six months, and will then be assigned to the New York City office.

C. R. OSBORN, vice-president in charge of the engine group of General Motors Corp., addressed an all-day conference of educators and industrialists at the Technological Institute of Northwestern University on "The Place of Cooperative Education in Modern Industry" on Nov. 8.

HAROLD HAAS is now plant engineer at the Dodge San Leandro Plant, San Leandro, Calif.

ALEXANDER ROY ANDRE is now project engineer for National Farm Machinery Cooperative, Inc., in Bellevue, Ohio. He was layout draftsman for Harry Ferguson, Inc., Detroit.

CHARLES B. BUNCH has been promoted to manager of the Dayton, Ohio, office of AiResearch Mfg. Co. of Los Angeles, Calif. Bunch was formerly field service representative. **ROBERT J. WRIGHT**, sales engineer for AiResearch, has been transferred to Washington, D. C., as assistant to the manager of the Washington office.

WILLIS A. EAST is now design engineer on auxiliary power units for the B-52 jet bomber with Boeing Airplane Co., Seattle. He was formerly powerplant engineer on the B-50. East is a member of a helicopter club which has bought the Jensen Helicopter Co. and is now readying a test model for public showing.

SAE's 1951 President **DALE ROEDER** and Mrs. Roeder were among those present when SAE Past President **R. J. S. PIGOTT** took office as 1952 president of the American Society of Mechanical Engineers last month. Pigott, who was SAE president in 1948, assumed his new presidential duties at the conclusion of the 72nd ASME Annual Meeting in Atlantic City, Nov. 26 to 30.

EUGENE S. CLARK is now with the gas turbine development group at Lycoming-Spencer Division of Avco Mfg. Co. in Williamsport, Pa. He was formerly staff engineer at Solar Aircraft Co., San Diego, Calif.

RALPH H. MERTZ, JR., who was staff assistant in the engineering laboratory of Ford Motor Co., Dearborn, has been recalled to active duty with the U. S. Navy.

ERNEST W. DUMLER is now an independent filtration consultant in Pittsburgh, Pa. He was formerly sales manager, automotive division, of Commercial Filters Corp., Boston, Mass. Dumler joined Commercial Filters in 1946 as assistant to the vice-president after 6 years in the Submarine Service.

CHARLES N. CROSSLEY is now mechanical designer for North American Aviation, Inc., Downey, Calif. Crossley was formerly design engineer for Redmond Co., Inc., in Owosso, Mich.

L. G. SROGI has joined the gas turbine development group of Lycoming-Spencer Division of Avco Mfg. Co., Williamsport, Pa. Srogi was previously with Bell Aircraft Corp., Buffalo, N. Y., as designer.

FEARSON S. MEEKS of S. J. Meeks Son, Washington, D. C., has been elected secretary-treasurer of the National Truck Body Manufacturers and Distributors Association.

CHARLES M. DANIELS, JR., who was specifications man for Hudson Motor Car Co., Detroit, is now studying engineering at Wayne University.

W. EVERT WELCH has been appointed administrative assistant on the staff of the manager of aero operations of Minneapolis-Honeywell Regulator Company's aeronautical division, Minneapolis, Minn. Welch was formerly assistant sales manager for the division.

RAYMOND T. SENDELL is now vice-president of Sanford Motors, Inc., Pittsburgh, Pa. He was formerly manager of truck sales for Steel City Motors, Inc., in Pittsburgh.

THOMAS Z. GREGORY is now salesman for Eubank-White Truck Corp., Richmond, Va. Gregory was formerly service manager of the Autocar Sales and Service Co. in Richmond.

NICK S. PERGAKIS has joined Monsanto Chemical Co., St. Louis, Mo., as maintenance and construction engineer at the W. G. Krummrich plant. Pergakis was formerly with the National Advisory Committee for Aeronautics, Cleveland.

LEONARD J. GRANKE is now an engineering checker for Long Mfg. Division of Borg-Warner Corp., Detroit, Mich. Granke was previously with Borg-Warner's Detroit Gear Division.

WILLIAM R. WOOD, who was tool liaison engineer for Chance Vought Aircraft Division of United Aircraft in Dallas, Texas, is now tool designer at the El Segundo, Calif., plant of Douglas Aircraft Co.

PAUL L. POLIZZOTTO is now industrial sales engineer for Union Oil Co. of California in Long Beach, Calif. He was formerly district sales manager for the company in Everett, Wash.

OSWALD L. SARAP is now aircraft and engine inspector for the U. S. Air Force Quality Control Section at Ford's Aircraft Engine Division in Chicago, Ill. Sarap was formerly assigned to GMC's Allison Division in Indianapolis.

MELVIN W. HALL is now sales and consultant engineer for Thompson Engineering Service, Fort Worth, Texas. Hall was formerly staff assistant and chief of engineering operations control of Northrop Aircraft, Inc., Hawthorne, Calif.

D. B. COYLER, JR., formerly test engineer for GMC's Allison Division, is now an aerodynamicist for Sverdrup and Parcel, Inc., St. Louis, Mo.

HARVEY S. FIRESTONE, JR., has been awarded the Philander Chase Medal of Kenyon College. This award is made "to an outstanding church layman for devoted and distinguished service to the Protestant Episcopal Church." Dr. Gordon Keith Chalmers, president of the college, made the presentation at a special convocation.

OSCAR E. MASON has been elected vice-president and manager of Associated Engineers, Inc., of Springfield, Mass. Mason has been associated with Pratt and Whitney Aircraft for the past 12 years, and at the time of his resignation was executive tool engineer in charge of production engineering operations.

JAMES H. W. CONKLIN has been named general sales manager of the Philadelphia division of Yale and Towne Mfg. Co. Conklin was formerly with the sales department of Pangborn Corp., and prior to that was sales manager of the industrial truck division of Clark Equipment Co. He is a past president of the Materials Handling Institute.

H. L. ATWOOD, who was formerly president and general manager of Southern Nevada Industrial and Marine Industries, Inc., Las Vegas, Nev., is now associated with H. K. Ferguson Co., Inc., at Henderson, Nev., where the company is constructing a titanium metals plant.

EDWARD W. UPHAM has retired from Chrysler Corp. after more than a third of a century with the company and its predecessor. Upham entered the industry in 1913, after graduating from the University of Michigan, as the lone metallurgist among a dozen laboratory employees of the Maxwell Motor Co.

Edward W. Upham

Upham's most prized piece of equipment in the old Maxwell laboratory, a Leitz-Wetzler metallurgical microscope with camera attachment capable of 1000 magnifications, was so sensitive to vibration that trucks passing the laboratory could ruin the exposure. The laboratory had no electric furnace for heat treating experiments, so Upham built a miniature furnace capable of 2200 F.

When Chrysler Corporation was formed in 1925, Upham became chief metallurgist. Since then he has seen the company's engineering division grow to a group with 3000 employees and such equipment as an electron microscope capable of magnifying steel samples 22,000 times.

Upham joined SAE in 1924, and by 1925 was active in lubricants technical committee work in setting up the SAE system of viscosity numbers. He was chairman of the Fuels and Lubricants Technical Committee from 1928 to 1948. Upham was also one of the earliest contributers to the proceedings of the Steel Treating Research Society, a forerunner of the American Society of Metals.

Upham's plans are indefinite, and may include some work as a consultant. He and Mrs. Upham plan a Florida vacation, but will continue to make their permanent home in Birmingham, Mich.

OBITUARIES

WALTER S. PEPER

Metropolitan Section lost one of its stalwarts on Nov. 23 when Walter S. Peper (M '19) succumbed of a cerebral hemorrhage which he suffered while driving his car a week before.

He served, following several years of Governing Board work, as Metropolitan Section Chairman during 1933-34.

A Navy reserve aviator during World War I, Mr. Peper was active in aircraft sales and engineering in the post-Armistice years with Lawrance Aero Engine Corp. and Cox-Klemin Aircraft Co. as draftsman and designer.

During this period he took night courses at Brooklyn Polytechnic and won an M. E. degree in 1923.

The following year he joined Yellow Coach & Truck Co., Chicago, and later represented that manufacturer for a number of years in the eastern states.

Despite his earlier interest in aviation, he devoted most of his automotive career in sales and service of vehicles, automotive equipment and industrial machinery.

He was with Smith & Gregory, Inc., Ford dealers and equipment distributors and later was associated with J. F. Winchester in the reorganization of the Davisbilt Tank Co.

At the time of his death he had been with the Shepard Co., materials handling equipment manufacturer, in the Metropolitan area. His widow survives him.

JOHN W. THOMAS

John W. Thomas, former president and chairman of Firestone Tire and Rubber Co., died at his home in Akron on Nov. 26 at the age of 71.

A chemist, Thomas founded Firestone's research and testing laboratories in 1908. Harvey S. Firestone selected him for the job when Thomas was working in a rubber compounding laboratory in Akron. Thomas' innovations at Firestone won him election to the board of the company in 1916. He was named president in 1932, succeeding Harvey S. Firestone, and became chairman of the board in 1942. Upon his retirement 4 years later, Thomas was named honorary chairman, and continued to serve the company as consultant.

In recognition of his work in rubber research and in the development of synthetic rubber, the American Institute of Chemists presented Thomas with their Gold Medal award in 1945.

Born on an Ohio farm, Thomas worked his way through Buchtel College, now the University of Akron, where he was president of his class and captain of the football team. He received his BS in 1904.

Thomas had been an SAE member since 1918. He was chairman of the board of the University of Akron from 1926 to 1942, and a member of the board of the Akron City Hospital for many years. He is survived by his wife, two sons, and three daughters.

CHESTER S. RICKER

Chester S. Ricker died Dec. 5, after making a partial recovery from two brain operations. His age was 63.

For the past several years, Ricker had been Detroit editor of the American Machinist, while contributing technical articles to many publications. After graduating from Cornell University in 1911, he joined Henderson Motor Car Co., and later was with Stutz. During World War I he served with the Army Ordnance Corps and was for a time stationed in Detroit. He later returned to Detroit and was for many years in charge of the Ford account for McCann-Erickson.

Ricker was nationally known as a scorer and timer of auto and boat races. While a student at Cornell, he attended the Vanderbilt Cup Race of 1908 and scored it for his own interest. When the officials were unable to agree on the results of the race, Ricker's notations settled the dispute. He was official scorer for the first Indianaplolis 500 Mile Race in 1911, and has scored every 500 Mile Race since.

Ricker scored and timed every Harmsworth and Gold Cup race held in Detroit. He owned his own boat and was an enthusiastic participant in races and regattas.

Ricker had been an active SAE member since 1910. He is survived by his wife, son and daughter.

CHARLES R. LUND

Charles R. Lund, 57, died unexpectedly in his sleep on Sept. 19 at his home in Catonsville, Md.

Lund was manager of the farm sales department of American Oil Co. in Baltimore. He joined American in 1932 as sales engineer in the Philadelphia office. He was transferred to the company's general offices in Baltimore in 1937 to become chief engineer of the technical service department. After serving as manager of that department, he was named manager of the farm sales department in 1945.

Born in Fremont County, Iowa, Lund took a BS in electrical and mechanical engineering at the Milwaukee School of Engineering. He was a member of many technical and trade associations, including SAE, American Society of Agricultural Engineers, American Society of Lubrication Engineers, and National Farm Chemurgic Council.

Lund was director of rural youth activities for American Oil, and taught short courses in tractor and automotive maintenance at 16 colleges and many veterans' training centers. He was an enthusiastic worker for 4-H Clubs and Future Farmers of America, and a week before his death had been selected as one of the judges of the 1951 Future Farmers Foundation Award in Farm Mechanics.

BURNS DICK

Burns Dick, who was 68, died aboard the U.S.S. Mauretania on Oct. 30. He was returning from a visit with relatives in his native England.

Until his retirement in 1947, Dick was chief automotive engineer and consulting engineer for Wagner Electric Corp. in St. Louis, Mo. He had been with Wagner since 1913. Dick was born in London and educated at Kings College, London. He came to this country in 1910 after several years in the automotive industry in England.

Dick joined SAE in 1916.

GEORGE M. PAULSON

George M. Paulson, former chief engineer of B. G. Corp., died Nov. 30 in Englewood, N. J., after a long illness. He was 59.

Paulson was born in Council Bluffs, Iowa, and graduated from Carnegie Institute of Technology in 1920, after serving with Rickenbacker's 94th Aero Squadron during World War I. He joined B. G. Corp. in 1922. An authority on aircraft ignition, Paulson was noted for his development work on the shielded spark plug and the laminated mica plug. He was the holder of many patents.

Paulson was an associate fellow of the Institute of Aeronautical Sciences as well as a member of SAE. He is survived by his wife and daughter.

KIRKE K. HOAGG

Kirke K. Hoagg died at his home in Scarsdale, N. Y., on Dec. 11 at the age of 62.

Hoagg was United States and Canadian vehicle engineer for General Motors Overseas Operations. Born in Ingersoll, Ont., he graduated from the University of Michigan in 1913 and joined GMC's Hyatt Bearings Division. He had remained with General Motors ever since, serving in London, Tokyo, and other foreign cities.

Hoagg was a member of the Shenrock Club and Westchester Hills Golf Club as well as of SAE. He is survived by his wife and two sons.

CALENDAR

Atlanta Group—Jan. 21

Location not yet decided; dinner 7:00 p.m. General Motors Proving Ground Activity—K. A. Stonex, head of technical data department, GMC. Special Feature: 16 mm film.

British Columbia—Jan. 14

Hotel Georgia; dinner 6:30 p.m. Talented Transmissions—J. T. Bugbee, research engineer, Texas Co.

Buffalo—Jan. 17

Hotel Sheraton; dinner 7:00 p.m. Meeting 8:00 p.m. Topic: Rocketry, speaker to be announced.

Canadian—Jan. 22

Hotel Royal York, Toronto; dinner 7:00 p.m. Meeting 8:00 p.m. Aircraft Wheel and Brake Development—A. C. Gunsaulus, Goodyear Aircraft Corp.

Chicago—Jan. 21

Hotel LaSalle, South Bend, Ind.; dinner 6:45 p.m. Meeting 8:00 p.m. The J-47-23 Jet Engine—Neil Burgess, manager, gas turbine engineering, General Electric Co. There will also be a technical session with Frank Mock, Bendix Corp., as chairman.

Cleveland—Jan. 21

Wade Park Manor; dinner 6:30 p.m. Meeting 7:30 p.m. Hi-Jet System for Increasing Tool Life. Speakers: SAE Past-President A. T. Colwell, Thompson Products, Inc.; SAE Past-President R. J. S. Pigott, Gulf Research & Development Co.

Detroit—Jan. 28

Rackham Educational Memorial Bldg., small auditorium. Meeting 8:00 p.m. Panel Meeting on Automatic Transmissions. Speakers: Charles W. Mervine, Chrysler Corp.; Fred Solmes, Kaiser-Fraser Corp.; Bruce Edsall, Cadillac Motor Division, GMC. Social hour will be held in Snack Grille following meeting.

Metropolitan—Jan. 10

Ladies will be invited to attend this meeting. The Road is Yours—Rex Cleveland, who will cover cars of the past. Charles Chayne of General Motors will cover cars of the future.

Mid-Michigan—Jan. 28

Rolling Green Country Club, Saginaw; dinner 6:30 p.m. Meeting 8:15 p.m. Hydraulic Steering—C. W. Lincoln, chief engineer, Saginaw Steering Gear Division, GMC.

Milwaukee—Feb. 1

Milwaukee Athletic Club; dinner 7:00 p.m. Meeting 8:00 p.m. The Experimental High Speed Cummins Diesel Engine—N. M. Reiners, Cummins Engine Co.

Mohawk-Hudson—Jan. 9

Circle Inn, Larhams; dinner 6:30 p.m. Meeting 8:00 p.m. Removal of Metal by the Precision Honing Method. Speaker will be from the Micromatic Hone Corp. of Detroit. Moving picture "Generation of Metallic Bearing Surfaces" to be shown.

Montreal—Jan. 21

Hotel Mount Royal. The Sicard Snow Blower—J. D. Lavigneur, Sicard, Inc., and Bombardier Snowmobile—J. A. Bombardier, L'Autoneige Bombardier, Ltd.

New England—Jan. 8

Graduate House, M.I.T.; dinner 6:30 p.m. Meeting 8:00 p.m. LPG Fuels—Leonard Raymond, staff assistant, Socony-Vacuum Oil Co., Inc.

Northern California—Jan. 23

Engineers Club, San Francisco; dinner 6:30 p.m. Meeting 7:30 p.m. Talented Transmissions—J. T. Bugbee, research engineer, Texas Co.

Northwest—Jan. 11

Hotel Stewart; dinner 6:30 p.m. Meeting 7:30 p.m. Talented Transmissions—J. T. Bugbee, research engineer, Texas Co. Slides will be shown.

Philadelphia—Jan. 9

Engineers Club; dinner 6:30 p.m. Meeting 7:45 p.m., student meeting. Clear Writing for Easy Reading—

NATIONAL MEETINGS

MEETING	DATE	HOTEL
	1952	
ANNUAL	Jan. 14-18	Sheraton-Cadillac, Detroit
PASSENGER CAR, BODY, and MATERIALS	March 4-6	Sheraton-Cadillac, Detroit
AERONAUTIC, AIRCRAFT ENGINEERING DISPLAY, and TECHNICAL AIR REVIEW	April 21-24	Statler, New York City
SUMMER	June 1-6	Ambassador and Ritz-Carlton, Atlantic City, N. J.
WEST COAST	Aug. 11-13	Fairmont, San Francisco
TRACTOR	Sept. 9-11	Schroeder, Milwaukee
TRANSPORTATION	Oct. 22-24	William Penn, Pittsburgh
DIESEL ENGINE	Nov. 3-4	Chase, St. Louis
FUELS AND LUBRICANTS	Nov. 6-7	The Mayo, Tulsa

Norman G. Shidle, executive editor, SAE Journal.

Pittsburgh—Jan. 22

Hotel Webster Hall; dinner 6:30 p.m. Meeting at Mellon Institute at 8:00 p.m. Passenger Car Air Brakes—W. R. Williams, executive engineer, automotive division, Bendix Aviation Corp.

St. Louis—Jan. 28

Community Playhouse. Ladies night. Theater party and buffet supper.

Southern California—Jan. 10 & Jan. 29

Jan. 10—Rodger Young Auditorium; dinner 6:30 p.m. Meeting 8:00 p.m. Practical Aspects of Space Ship Design and Interplanetary Travel—C. T. Aubrey, owner and general manager, Telair Engineering.

Jan. 29—Talented Transmissions—J. T. Bugbee, research engineer, Texas Co.

Southern New England—Feb. 7

The Hedges; dinner 6:45 p.m. Meeting 8:00 p.m. Flight in Outer Space and Interplanetary Travel—Willy Ley, author of "Rockets and Space" and founder of German Rocket Society. 1952 SAE President Dr. D. P. Barnard IV will be present.

Texas—Jan. 11 and Feb. 8

Jan. 11—Truck and Bus.
Feb. 8—Fuels and Lubricants.

Western Michigan—Jan. 22

Dinner 6:30 p.m. Meeting 7:45 p.m. Aircraft Gas Turbine Development—Carl Bachle, development engineer, Continental Aviation & Engineering Co.

Williamsport—Jan. 7

Williamsport Airport Dining Room; dinner 6:45 p.m. Meeting 8:00 p.m. Our Ruined Roads—A. B. Gorman, Esso Standard Oil Co.

Virginia—Jan. 28

William Byrd Hotel; dinner 7:00 p.m. Meeting 8:00 p.m. Carburetion and Ignition—W. E. Bailey, engineer, Holly Carburetor Co. Social hour 6:30 p.m.

25 Years Ago

Facts and Opinions from SAE Journal of January, 1927

The present type of pursuit airplane, with its speed of 160 mph, is not as good as is needed. Engineers should try to develop a machine capable of a speed of 200 mph.—Major T. J. Lanphier, Selfridge Field.

■

It is the duty of builders to put lamps on cars that the average motorist can use. Any complication in construction that makes assembling of the headlamp difficult for the average motorist should be given careful consideration. Adjusting mechanisms should be as few and simple as possible and should be placed in accessible positions.—A. W. Devine, Registry of Motor Vehicles, Commonwealth of Massachusetts.

■

The Iron and Steel Division has approved the recommendation of the Subdivision on Hardness Tests that the Rockwell Hardness Tests should be included in the present SAE Recommended Practice for Hardness Tests.

■

If valve and valve-operating mechanisms can be brought down to a point where they approach the present-day racing engine, passenger car speeds can be increased about 25 to 30% and better efficiency will result.—F. S. Duesenberg, Duesenberg Motors Co.

■

The thermal efficiency of the tractor engine is much higher than that of the automobile engine. But it is still far below that of the best stationary engine and offers room for substantial improvement—perhaps along the line of the constant compression engine.—J. B. Davidson, Iowa State University.

One of the fundamental difficulties under which the whole subject of gearing has labored has been the lack of development of a satisfactory and easily handled method of measurement. Measuring all the variables that may concern or be wrong with an involute gear is a very complicated problem.—B. B. Bachman, Autocar Co.

■

The all-steel body has an important place in mass car-production. But prominent men in industry feel that the fabric body will come into extensive use in this country, as it has in Europe.—Discussion at Indiana Section Meeting.

■

Surprise was created at the Tractor Meeting by William Parrish's (International Harvester) statement that approximately 12% of all tractors that have been produced have gone into industrial use.

■

Urge of the present period is to produce high antiknock motor fuel in quantities sufficient to operate high-compression engines—which must come on the market so that better economy will be obtained.—Gustav Egloff, Universal Oil Products Co.

■

A survey on a fleet of 19 trucks operating in New York City revealed that—since cushion tires were used—the accident premiums were lowered \$1800 per year, or practically \$80 per truck.—A. L. Schoff, Overman Cushion Tire Co.

SAE Section Meetings

Supersonic Flight Creates Pilot Problems

• Washington Section

Nov. 20—Problems of flight at supersonic speeds were discussed by **Maj. Charles E. Yeager** before a "standing room only" audience of Washington Section members and guests. Yeager, who is test pilot and chief of operations section at the Air Force Test Center, Edwards Base, Calif., highlighted his talk with tales of personal experiences.

Pilot limitations present serious problems in air fighting at sonic speeds, Yeager said. A plane traveling at sonic speed will have traveled some 1800 ft between the time another plane first becomes visible and the time the pilot can recognize it, and will travel another 5000 ft before he can move his arm to maneuver the plane.

So far problems of temperature rise of the airplane skin have not been serious, because the planes now being tested are not capable of supersonic speeds for extended periods. Temperature rise due to supersonic speeds may amount to 200 to 300 F, but this will not create problems until the speeds are maintained for several minutes, since airplane and pilot are thoroughly chilled during the climb to such altitudes.

Lack of oxygen creates serious problems at high altitudes. First effect is lack of coordination in the pilot, which starts at about 16,000 ft. The average pilot loses control of his muscles at altitudes above 18,000 ft, and will gradually lose consciousness above 20,000 ft.

It is impossible for the pilot to escape from the cockpit at speeds above 300 to 400 mph, because of the terrific forces on the plane at such speeds. An ejection seat has been developed which is automatically thrown out by an explosive force when the pilot pushes an emergency release lever. Several successful escapes have been made by this method, both in tests and in real emergencies, and pilots have survived when accelerations of up to 14 *g* were developed.

Next development in this field will be an ejection capsule, in which the pilot will be thrown out in an enclosed capsule, so as not to suffer from lack of oxygen while descending from heights of 40,000 or 50,000 ft.

Fuel requirements of supersonic flight are huge. The X-1 plane consumes nearly 600 gal of fuel in 2½ minutes of flight, at a cost of around $800, said Major Yeager.

Training pilots for fighting at high altitudes requires a special course, Yeager said. It is impossible to take pilots who are thoroughly trained in combat fighting at 20,000 to 30,000 ft and assign them to high-speed jet craft for combat at 40,000 to 50,000 ft.

Arnold Kruckman, Washington reporter for several midwestern newspapers, was coffee speaker. As a reporter for the New York World, Kruckman witnessed the Wright brothers early flights at Kitty Hawk in 1908, Glen Curtiss' first flights, and was the first full-time aviation reporter. The Wright brothers, Kruckman recalled, refused permission to reporters to witness their trial flights, so Kruckman had to hide among the sand dunes to get the story. When he telegraphed his report to the World, the paper refused to publish it on the grounds that it couldn't be true.

British Lead U. S. In Jet Design, Hurley Says

• Syracuse Section

Courtney F. Dolan, Field Editor

Nov. 14—**Roy T. Hurley**, president and chairman of Curtiss-Wright Corp., led a lively discussion on British jet engines at a joint meeting of Syracuse Section and the Syracuse Technology Club.

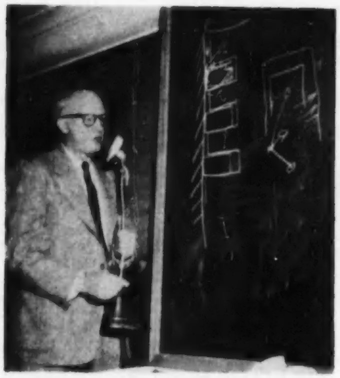
One questioner asked why America should have gone to England for engine models. Hurley, who visited England early this year to obtain the Sapphire and Bristol engine models, said that the British have proceeded on the assumption that there will be no war until 1956. They have therefore put their limited resources into research and development, and have produced not only the best engine to date for its purpose, but one capable of 50% improvement at short notice.

Why have the Russians kept so well abreast in their MIG model, Hurley was asked. He answered that the Russians bought an English model and put their German technicians to work on it.

Hurley said that in World War II the production of Curtiss-Wright had been increased to 45 times normal production. To date the Korean crisis has brought the company's production to 26 times normal.

Chairman C. F. B. Roth of Aircooled Motors introduced Hurley.

At the Nov. 14 meeting of Syracuse Section, held jointly with Syracuse Technology Club, Roy T. Hurley answered questions on British jet engines. Left to right: John L. Collins, New Process Gear Corp.; Carl F. Dietz (standing), Lamson Corp.; Roy T. Hurley, president and chairman of Curtiss-Wright Corp.; Forrest McGuire (standing), Manufacturers Association of Syracuse; Dr. Earl F. Apfel, Technology Club vice-president; Syracuse Section Chairman C. F. B. Roth, Aircooled Motors



At the Nov. 14 meeting of Northern California Section, C. G. A. Rosen illustrates the effect of piston rings in sealing combustion pressures

Chemical Research Needed For Improvement of Diesels

• Northern California Section

J. C. Ellis, Field Editor

Nov. 14—Recalling the heritage of the West in the development of the internal combustion engine, **C. G. A. Rosen**, consulting engineer for the Caterpillar Tractor Co., said that he would be pleased if he could stimulate the group to even greater advances in automotive engineering. The problems confronting the diesel engine builder have been problems of the engineer, says Rosen, but solutions through design changes alone are approaching the law of diminishing returns and a greater emphasis must be placed on chemical research.

A survey of the combustion chamber envelope reveals that this portion of the diesel engine must serve as

1. a chemical retort,
2. a heat exchanger, and
3. a pressure sealing vessel.

With respect to the envelope as a chemical reactor, he says the formation of suitable fuel/air mixtures before ignition must be accompanied by a close control of the nucleus of ignition during the combustion cycle to ensure smooth operation. Improvements have been effected by combustion chamber design, but because of the complexity of the reaction additional study is required of the various stages of combustion, with particular emphasis on the intermediate stages. Efficiencies may be increased through supercharging with reductions in both compression ratios and friction horsepower being realized. He reasons, however, that advances along these lines must follow the development of better blowers incorporating intercoolers to reduce intake air temperatures.

The heat of reaction in the combustion chamber envelope leads to temperatures which approach 4000 F, and this heat must be dissipated efficiently to prevent failure of component parts. Rosen states that approximately 15% of the heat carried off through the piston is transmitted through the rings with the remainder passing through the skirt area. He reasons it would be desirable to dissipate a greater portion of this heat through the crown area, and this may be realized through closer attention to piston clearances. New metallurgical developments also will bring about improvements.

Pointing out the importance of piston ring design in sealing combustion pressures, he stressed also the part played by rings in aiding lubrication and controlling oil consumption. The top compression ring is the primary pressure sealing unit and, if functioning adequately, requires little help from the second ring in this respect. The third ring is primarily an oil distribution ring, spreading the lubricant around the cylinders, while the oil rings serve simply as scrapers to remove excess oil.

Because a number of his slides failed to arrive in time for the meeting, Rosen illustrated his paper with a series of blackboard drawings. These were handled so expertly that the audience of 135 guests and members were not at all displeased that the slides were missing. Warren Brown, vice-chairman for diesel activity, was technical chairman for the session.

New Uses for Aluminum In Highway Transporation

• Cleveland Section

Lowell O. Ray

Nov. 12—"In 1953 the aluminum industry, using facilities now under construction, will be producing nine times more metal than was produced in 1938," predicted **J. H. Dunn**, assistant development engineering manager at Aluminum Co. of America's Cleveland plant. Dunn's talk followed a tour of the plant and research facilities by some 300 members and guests of Cleveland Section.

In the future, as in the past, about 18% of aluminum output will be available for the highway transportation industry, said Dunn. The result of this significant increase will be a greater use of aluminum for automotive cylinder heads, radiators, crank cases, battery cables, bearings, wiring, brake drums, tubing, and hardware.

Dunn detailed the new process of "brazing" aluminum, which enables

J. H. Dunn (left), assistant development engineering manager at the Cleveland plant of Aluminum Co. of America, described some recently developed applications of aluminum for highway transportation at the Nov. 12 meeting of Cleveland Section. A tour of Alcoa's Cleveland facilities preceded the talk. At right, George A. Butz, Jr., Alcoa development engineer, explains Whirlpits to some of the visitors

the mass production of sandwich-type applications. This process will permit practical and less expensive production of aluminum engine parts in competition with cast iron.

The recently developed forged aluminum wheel, said Dunn, has been reported as giving as much as 25% more tire life by some users of the 100,000 such wheels now traveling the highways.

Aluminum trailers, now universally used by the trucking industry, have proved the value of weight saving, said Dun. Aluminum tractors with weight savings as high as 3000 lb per unit are now in the process of development.

Dunn used slides in describing the design and production of an aluminum coupe body for Willys-Overland. Although the final product achieved a weight saving of 300 lb over the conventional model, the cost was too high to meet the demands of today's automobile market. Dunn discussed in detail the aluminum and magnesium applications of General Motors' experimental car "Le Sabre" and Buick's XP-300.

Dunn emphasized the absolute necessity of designing for aluminum, rather than adapting designs intended for some other metal.

In the tour preceding the talk, members visited X-ray rooms, a constant temperature room, stress laboratories, the research foundry, and saw demonstrations of vibration, heat and friction tests used in the development of new aluminum applications. A display of Alcoa products in the plant dining room included a multitude of aluminum finishes and current aircraft and automotive applications.

Chairman R. I. Potter opened the after-dinner speaking program with a brief history of the discovery and early uses of aluminum. Frank Jardine, Alcoa's Cleveland development engineering manager, introduced the speaker.

High Speeds Create Aircraft Pressure Problems

• Wichita Section

Chuck Allison, Field Editor

Dec. 5—"Aircraft Pressurization and Cooling" was the subject of a paper by **Angus McDonald**, application engineer of the Stratus Division of Fairchild Engine and Airplane Corp., Farmingdale, New York. Cooling is the principal problem of pressurization in high speed aircraft, he stated, as cabin temperatures can go as high as 200 F and, as speeds increase, they probably will go as high as 350 F. The general method of solving a pressurization and cooling problem is first to determine the cooling load, which consists of four main items: skin friction, solar load or sun, electronic heating, and body heating. Next, the pressurization schedule is determined. This schedule is arbitrary, depending on the mission or use of the aircraft. From this information the type and size of cooling unit can be determined.

McDonald prefers the air cycle system over the vapor cycle system, because it produces more cooling per aircraft hp. To illustrate and explain the bootstrap system and simple system, he used cutaway models and slides. A slide of the air cycle unit for portable ground equipment was also shown.

Most of the pressurization problems of present-day aircraft have been solved, McDonald stated. But with the speed of aircraft increasing rapidly, many new problems will be created because of extremely high temperature cooling air. He said there would be a demand for the air cycle cooling system for commercial transports as their operating altitude approaches 40,000 ft.

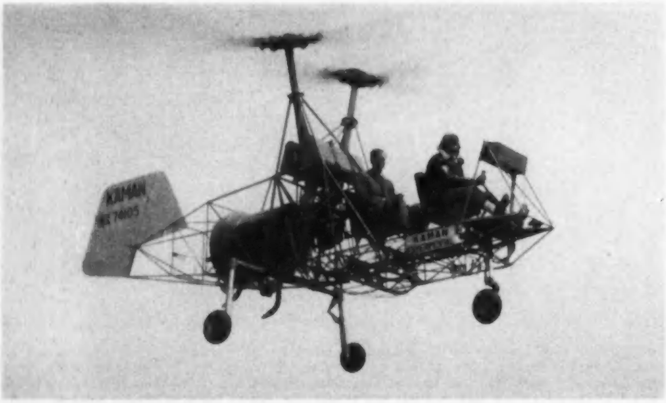
A special feature of the Wichita Section monthly meeting is a speaker on some subject of community interest. At this meeting Ford Rockwell, who is head of the public library system, spoke on the technical value of the library and the expanding program planned for the future.

"Mechanical Octanes—the answer to X equals what" was the title of the paper that Alex Taub of Taub Engineering Co. presented at the Nov. 8 meeting of Southern New England Section. Left to right: L. M. Porter and C. O. Broders of Pratt and Whitney, Alex Taub, and Hans Hogeman of American Bosch

Helicopter rescue work on the Korean battlefronts was described by Joseph Mashman, test pilot and assistant contract manager of Bell Aircraft Corp., at a joint meeting of Syracuse Section and the Syracuse Technology Club Oct. 8. Mashman showed the film "Mercy has Rotary Wings" which he assembled in a visit to Korea last spring from movies taken by combat soldiers. Left to right: Mark N. Russell, Technology Club president; Joseph Mashman; Syracuse Section Chairman C. F. B. Roth, president of Aircooled Motors Corp.; and Dr. Ralph A. Galbraith, dean of Syracuse University College of Applied Science

At the Central Illinois Section meeting Nov. 19, Robert S. Lee of Twin Coach Co. spoke on the merits of propane as a fuel for buses. Left to right: J. M. Van Lanen, president of the Peoria Engineering Council, who as coffee speaker described the work of the Council; Robert S. Lee; Robert V. Larson of Caterpillar Tractor Co., technical chairman of the meeting; and Section Chairman J. W. Vollentine of Caterpillar

At the Nov. 19 meeting of South Bend Division of Chicago Section, C. N. Hinkle (left) described the transition of farm machinery from the horse-drawn age to the equipment of today. C. C. Vanderberg (right) of Clark Equipment Co. was technical chairman of the meeting



John O. Emmerson, chief engineer of Kaman Aircraft Corp., is observer in an early Kaman experimental helicopter, with Bill Murray at the controls. Emmerson was speaker at the Dec. 3 meeting of Williamsport Group

Future Development Of Convertaplane Predicted

• Williamsport Group

Allan Creighton, Field Editor

Dec. 3—Ultimate development of the helicopter within ten years, and a shift of principal new design effort to the convertaplane was forecast by **John O. Emmerson**, chief engineer of Kaman Aircraft Corp. The speaker described early development of the Kaman servo-flap as used in the Kaman side-by-side intermeshing twin-rotor aircraft. An interesting point was that an increase in flap angle instead of increasing the rotor lift decreased the lift by deflecting the rotor to a decreased angle of attack. Subsequent rotors were made flexible in torsion from the hub to the flap station and rigid beyond that point. This permitted the use of a very small servo-flap with low control forces and led to the development of the "tea cup" azimuth control, so called because of its minute size.

Emmerson traced the design changes which brought about improved stability and control and the trend toward increasing power requirements as the designs progressed. The intermeshing contra-rotating rotors eliminated the need for a torque-compensating tail rotor. Directional stability was accomplished by eliminating the steerable rudder and by cocking one of the side-by-side rotor shafts slightly forward, and the other to the rear. The rudder pedals are attached to vary the rotor collective pitch and give a torque differential between the rotors which provides positive directional response. Vertical stability is inherent in the use of intermeshing rotors whose blades move forward high in the center and return low on the outside. The reaction on the ship to increasing the power to the rotors is to put the tail down, which is the desired direction.

Directional control in autorotation required that the rudder controls be reversed and this was built into the control linkage. Crossing the pilots legs to accomplish this reversal was not satisfactory, Emmerson added parenthetically.

Following his talk, Emmerson ran a film showing control characteristics at various stages of their development program culminating in their new model HTK-1 single boom twin tail design. Some shots of crop dusting were included. A remarkable demonstration of the effectiveness of the helicopter downwash in dusting tobacco thru the overhead netting was shown by pictures taken under the netting as the ship passed over.

Questions following the talk brought out that spot landings can be made in autorotation and that a relatively

safe landing could be made with power failure at 100 ft with nothing worse than washed out landing gear by flaring out to full collective pitch in the last 10 ft of descent.

The limitation on forward speed is stall of the retreating blade. Some improvement in this direction may be possible with symmetrical sharp leading edge rotor air foil for high Mach number rotor tip speeds.

The scroll of achievement was presented to John Hospers in appreciation for his service as chairman of the Williamsport Group last season by Adam Sieminski.

Modern Tractor Outmodes Old Gray Mare

• Chicago Section

D. J. Schrum

Nov. 19—The farm tractor industry was described as a symbol of American ingenuity by **C. N. Hinkle**, agricultural engineer of Standard Oil Co., at a meeting of South Bend division.

The development of a machine to replace horses in breaking new ground in the middle West took many forms, all of which were intended to supply motive power to existing implements, said Hinkle. The first of these was the steam engine, with its extreme weight and accompanying fire hazard. Supply of water and fuel was a problem, but the advantages of mechanical power had been demonstrated. The transition to internal combustion engines for farm machines accompanied development in that field.

As these early tractors were pressed into use for working over previously used fields, miring and dust problems brought a demand for lighter weight, better traction and control, and dust cleaners for the engine. These improvements increased versatility; the tractor began to move East, where new problems were met with row crops, contouring, and other soil conservation measures. Implements designed specifically for mechanical use replaced those designed to be horse-drawn, and new tools only possible with mechanical power were developed.

Thus the race between manufacturers fulfilling user's demands and users finding new demands has brought rapid progress in the 50 year old farm machine industry.

Hinkle's talk was illustrated by slides of early and modern tractors and highlighted with stories of his experiences with the early machines. C. C. Vanderberg was technical chairman of the meeting.

Evaluation Tests For Used Diesel Oils

• St. Louis Section

W. H. Cowdery, Field Editor

Nov. 13—**Leland A. Wendt**, products application department, Shell Oil Co., described the chief methods of evaluating used diesel oils.

The life of a lubricating oil, Wendt said, is a function of the quality of the oil and the conditions under which it is used. Chief causes of deterioration are contamination and the effects of extremes of temperature.

Heavy duty oils may wear out in the sense that, while the base oil is not impaired, the additives that gave it certain superior qualities are consumed, Wendt said.

Different methods of determining when a heavy duty oil should be drained are in practise, but there is general agreement that oil should be drained if normally measured physical properties vary significantly. Viscosity should be determined to help establish the presence of fuel dilution and indicate thickening of the oil through oxidation or contamination with insolubles. Combinations of flash tests and viscosity give a reasonable indication of dilution. Oil sludge content is determined by a number of methods.

Ash content is often determined to indicate the presence of additives. The drawback of this test is that it does not necessarily indicate additive **effectiveness**; in some cases samples have been inspected which had the same quantity of ash and additive metal, but in which the additives in one sample had changed in composition and lost effectiveness. The spectrograph, which is used by some railroads for oil evaluation, also fails to indicate the effectiveness of additives.

Thus far there are no widely accepted analytical tests for evaluating effectiveness of additives, but two simple tests have been developed for indicating the effectiveness of oxida-

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You'll Be Interested To Know . . .

THE JAPANESE PEOPLE "drown in the whirlpool of delight because of the peace treaty being signed thanks to U.S.A. Government and people." This we have on the authority of Isao Nishimura, assistant of the agricultural machinery section, faculty of agriculture, University of Kyoto, Japan. Mr. Nishimura tells us this in a letter received about the middle of September, asking for a copy of the paper by H. A. Ferguson on "Hydraulic Control System for Farm Tractor Implements," presented at the 1950 SAE National Tractor Meeting.

MORE SAE MATERIAL is being used for educational purposes than ever before. Illustrations from an SAE paper recently went into a series of Fort Wayne, Ind. talks designed to teach citizen groups the constructive uses of atomic energy. . . . SAE material now forms part of a U. S. Naval Academy text specially written for the Academy's course in internal combustion engines. Seniors at the U. S. Military Academy use an SAE Journal article on revised SAE oil grades for supplementary reading in their automotive course.

At Aberdeen Proving Ground, the Ordnance School's monthly digest for Ordnance instructors reprints SAE items that are of value in Ordnance training. . . . An SAE paper on military wheeled transport vehicle requirements has been made background reading for officer students at the Ordnance School of the Detroit Arsenal.

Industry training programs, too, find SAE material helpful. One company feels SAE material often will further its aim of promoting more effective utilization of equipment built by the company. . . . Another has found an SAE paper on splines and serrations helpful in explaining to engineers and draftsmen the concept of dimensional and effective fits in splined parts.

SAE at Case

Case Institute of Technology is not only the oldest private technological school west of the Alleghenies, but one of the earliest colleges in the country devoted primarily to engineering studies.

Founded in 1880 by Leonard Case in the old Case homestead near Cleveland's public square, the college moved to what is now University Circle when a group of citizens donated a tract of land to Case and Western Reserve University, which came to the site from Hudson, Ohio. The Circle now includes the Cleveland Museum of Art and Severance Hall, home of the Cleveland Symphony, and forms a cultural center of Cleveland.

The Institute, then named Case School of Applied Science, early attracted men of high ability. Albert Michelson conducted his ether-drift experiments, since made famous by Albert Einstein, in collaboration with Edward Morley of Western Reserve. Charles Frederic Mabery, through his contributions to petroleum chemistry, and Charles Sumner Howe, mathematician and second president of Case, helped to establish the reputation that continues to attract teachers and students of high caliber to Case.

Case's department of mechanical engineering was founded in 1887, with Charles H. Benjamin as first professor. Benjamin, who recognized the problem of smoke in America's growing industrial centers, also served as Cleveland's first smoke abatement officer.

With the erection of the Bingham Engineering Building in 1927 and the Worcester Reed Warner Laboratory of mechanics and hydraulics in the following year, the department came of age. The teaching staff now numbers almost twenty.

The Case tradition of civic participation is carried on by Dr. T. Keith Glennan, president since 1947. Dr. Glennan, who during World War II directed the Navy Underwater Sound Laboratory, is now on leave of absence to serve on the Atomic Energy Commission.

Aerial view of Case

Photo by Cliff Crabs

Case aims at a student body of moderate size—now about 1500—and a ratio of only slightly more than ten students to one faculty member. An established part of the Case system is required participation in "practise terms." At the end of freshman year, all students except those in chemistry, who have a practise term on campus, depart for two weeks at Camp Case at Mohican State Forest Reservation for practical work in surveying. Civil engineering students follow up with a four week visit to Camp Case after sophomore year, while students in other branches make appropriate trips.

The SAE Student Branch at Case was chartered in January, 1946. Although an active SAE Club existed for several years before, the rapid turnover of students during the war years presented a problem; in 1944, 60% of the members of the Club were Navy V-12 students, while accelerated courses made heavy demands on civilian students. With the warm help of Norman Hoertz and Robert Cummings, student chairmen of Cleveland Section, the Club continued to grow, and by 1945 was 10th in size of the 55 SAE Clubs.

By the spring of 1950 the SAE Student Branch at Case was one of the most active of the many extracurricular activities at Case, and talks on such subjects as "Fuels, Lubricants, and Hot Rods," by Raymond Potter of Sandard Oil, "The Chevrolet Powerglide," by H. O. Flynn of Chevrolet, and "The Diesel Engine," by Carl Bierlein of GMC Cleveland Diesel Division, attracted so many guests that attendance was more than twice the number of Student Branch members.

For the annual open house at Case that spring, the SAE Student Branch prepared a display that included a full size cutaway Allison J-35 turbojet engine and was one of the most popular exhibits.

Under the present officers, Robert Broderick, Howard White, and Clifford Crabs, with James Jeromson as faculty adviser, membership has continued to grow despite the drop in total enrollment to normal levels. Outstanding among recent presentations were T. J. Durkin's discussion of air brake systems and T. R. Thoren's lecture on flexible oil rings, booster fuel pumps, and rotary valves.

Institute of Technology

Among SAE Members who Attended Case Institute of Technology are the following:

C. J. Abbott (1907-11), Ellsworth C. Adams (1941-43, 1946-48), Henry E. Alquist (1946-48), William S. Allan (1912-16), Richard Allchin (1941-43, 1946-47), Walter D. Appel (1909-13), Richard Arnold (1933-41), Arthur P. Armington (1939-42), J. H. Baird (1928-32), Roy Balogh (1936-40), James J. Barrett (1930-34), Edward G. Belden (1943-43, 1946-47), Kenneth C. Bell (1947-50).

Irwin A. Binder (1925-30), F. L. Bird (1937-41), Ben H. Blair (1905-09, 1909-11), T. R. Blakeslee (1936-41), Herman V. Boley (1914-17, 1919-20), Ralph K. Boyer (1945-48), Norman H. Brandt (1944-48), W. R. Breeler (1917-21), Edwin A. Brezina (1936), W. E. Brill (1921-25), Frank W. Brooks (1931-35), Morton Brooks (1937-41), Richard E. Brown (1939-42), Robert E. Busey (1928).

Byron F. Campbell (1930-35), M. H. Campbell (1939-40), R. J. Carleton Jr. (1938-43), John J. Carlin (1940-43, 1946-50), George S. Case (1900-04), William A. Catalano (1930-34), Richard J. Cerny (1934-39), J. T. Cieszko (1936-41), J. Clark (1920-24), Robert O. Collins (1943-47), Arthur J. Cook, Jr. (1935-40), R. E. Cummings (1929-33), E. Charles Curtis, (1936-38), Pitt A. Curtiss (1946-49).

William T. DeCapua (1922-26), Norman L. Deuble (1916-20), Neff T. Dietrich, Sr. (1919-23), Albert C. Dreschler (1937-41), Donald R. Dreger (1948-51), Harold D. Duppstadt (1930-32).

William K. Ebel (1921-23), Arthur C. Echler (1939-42), Robert A. Edwards (1937-41, 1943-47), Karl A. Eger (1915-19), Rodger J. Emmert (1912-16), Clarence H. Endress (1909-13), Leonard Epstein (1942-45).

Edward H. Farmer (1924-28), J. Elmo Farmer (1932-37), John O. Findeisen, Jr. (1936-40), Harry Edward Figgie, Jr. (1941-43, 1946-47), Leonard C. Fisher (1924-28), Charles MacKenzie Fluke (1937-41), Delton R. Frey (1928-32, 1943), Stanford J. Friedman (1945-47, 1947-49), T. A. Frischman (1921-25), Hans E. Fueger (1940-43), James H. Fuller (1932-36).

R. H. Gale (1925-29), Daniel C. Garger (1942-43, 1946-49), Robert M. Geisenheyner (1939-43, 1945-46), W. Bryant Gemmill (1926-30), C. F. Gerhan (1922-26), C. F. Gilchrist (1900-04), Allen H. Glasenapp (1928-32), Glenn R. Graham (1937-41), Walter Grothe (1895-99).

William L. Hamilton (1939-42), Charles M. Hannum (1928-32), Robert A. Harmon (1940-41, 1942-43, 1946-47), Herbert Benjamin Harris (1939-42), Carl L. Harvey (1917-21), Clarence A. Herman (1924-28), Francis U. Hill, Jr. (1947-50), Leslie W. Hoberecht (1941-43, 1946-48), Robert F. Hodgson (1936-40), Louis W. Hodous (1911-15), Kenneth A. Honroth (1938-46), Howard L. Hopkins (1925-30), H. Franklin Hostetler (1946-48).

Eugene V. Ivanso (1927-32), Herbert S. Jandus (1901-05), Clarence A. Jarosz (1941-44), John F. Jones (1937-41), Robert C. Junvinall (1935-39), Raymond J. Karabinus (1947-48), O. J. Kelley (1934-37), Edward D. Kemble (1924-28), Elmer A. Kemp (1937-44), Melvin Daniel Kilmer (1939-43), E. G. Kimmich (1909-13), Larry H. Kline (1942-45), W. L. Klingman (1931-35), C. H. Kuthe (1928-32).

George T. Ladd (1934-38), Clifford J. Lane (1919-25), Ross E. Lewton (1914-16), Roy E. Marquardt (1938-42), M. J. Markowski (1939-44), V. P.

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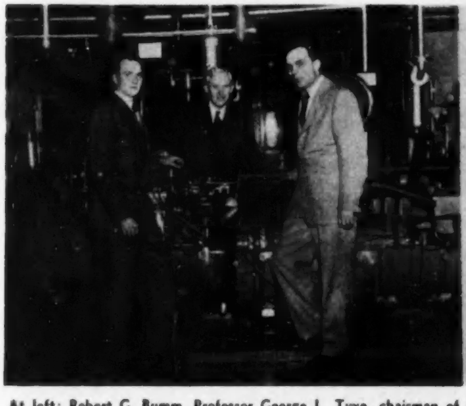


At left: Robert G. Bumm, Professor George L. Tuve, chairman of the mechanical engineering department at Case, and Robert Broderick, chairman of the Student Branch, with a German jet engine. At right: James R. Jeromson, faculty adviser to the Student Branch, Clifford Crabs, secretary-treasurer, and Howard E. Conlon, publicity chairman, examining a Plymouth engine test stand

SAE Members Who Attended Case Institute of Technology:

Continued

Mathews (1913-17), John F. McCorkindale (1934-39), Thomas F. McGann (1943-46), W. McKee (1922-26), F. Richard Merriam (1937-42), Joseph E. Micksch (1939-41, 1946-48), Ralph A. Minke (1922-26), W. R. Mogg (1932-36), Wilson H. Moriarty (1914-18), John D. Morron (1909-13, 1927), Paul Myron (1932-36).

F. Alex Nason (1918-22), James Nassau (1939-42), William R. Neely (1934-38), Bernard T. Novy (1941-45), William Card Nusbaum (1941-44), Charles W. Ohly (1936-40), Dan Frank Ostrowski (1945-49).

Robert D. Pae (1937-41), Clarence John Parker, Jr. (1922-25), Leslie O. Parker (1905-07), Starr W. Pearn (1937-41), E. G. Pekarek (1935-39), W. G. Piwonka (1921-25), Joseph A. Poremba (1937-41), R. I. Potter (1930-33), Richard B. Proudfoot (1930-34).

Eldon K. Ralston (1925-29), William G. Raney (1940-42), David L. Raymond (1938-42), Gomer H. Redmond (1939-42), L. W. Reeves (1922-26), William J. Resch (1930-34), Robert B. Resek (1947), Joseph H. Richards (1937-41), R. M. Richardson (1931-35), Edward P. Riley (1927-32), T. L. Robinson (1913-17), Philip B. Rockwood (1933-37), John Rogos, Jr. (1945-49), Milton S. Roush (1929-35).

Frank J. Sargent (1930-34), Richard J. Schager (1937-41, 1942-47), Karl Scheucher (1935-39), Jack Edward Schmitt (1940-43), John M. Schnetzler (1939-42), H. E. Schroeder (1919-23), Howard W. Schultz (1923-27), Lewis A. Schultz (1944-47), Robert C. Schutt (1938-41), Robert E. Schwary (1937-46).

W. B. Seaver (1934-40), Carl Severin (1906-10), T. F. Shaffer (1925-31), Bob W. Sheflin (1937-41), D. A. Sherick (1930-34), John J. Sibisan (1937-41), David C. Spaulding, Jr. (1922-26), Donald H. Spicer (1924-29), Krell E. Spires, Jr. (1943-45), J. R. Splitstone (1935-37).

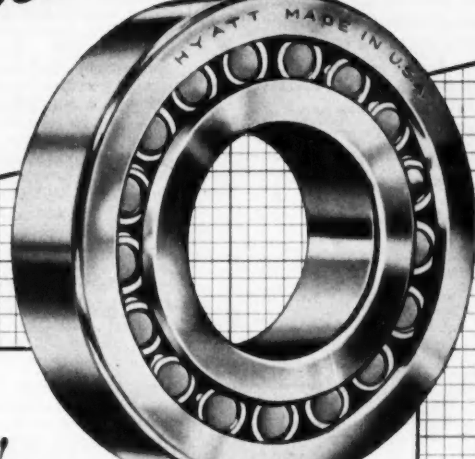
S. C. Stanley (1910-14), Theron D. Stay (1910-14), Hoy Stevens (1918-22), David A. Stoddart (1947-49), Harold H. Stroebel (1946-50), Herbert C. Snow (1902-06).

George E. Tanker (1932-36), R. B. Temple (1918-22), Thomas H. Terry (1940-44), E. Arthur Thompson (1945), William Thorrat (1945-49), Werner F. Timm (1941-42), Bruce O. Todd (1935-39), Alexander O. Toth (1940-49), A. Townhill (1921-25), Ralph E. Tuttle (1947-50), Walter C. Voss (1902-06).

Robert B. Wallace (1936-40), Robert M. Ward (1938-41), A. E. Weiss (1911-15), William H. West (1922-27), Charles A. Wildman (1919-23), Ivor H. Williams (1919-23), Robert E. Willison (1939-42), Paul I. Wilterdink (1948), Royale Wise (1918-22), Frederic D. Wyss (1935-40), R. E. Zimmermann, Jr. (1940-42), Anthony J. Zino, Jr. (1930-34), Harold J. Zuske (1930-35).

1892–1952

60 Years serving industry



. . . and still going like sixty!

Continuing progress has marked the last fifty-nine years for Hyatt. But 1952, our sixtieth year, finds us expanding our facilities in anticipation of the greatest year in our history.

Plant extensions, under way right now, are adding valuable manufacturing space at Harrison, and additional construction will double the available floor space at our second plant in Clark Township, New Jersey.

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HYATT ROLLER BEARINGS

SAE Section News

Continued from Page 89

tion inhibitor and the dispersant detergent. One is the blotter test. Blotter spot tests are useful for straight mineral oils, where a filter change makes a considerable difference in the density of the center of the oil spot, but less conclusive with heavy duty oils. The second test is dark field microscope inspection, in which light is reflected from the oil sample into the microscope. The dark field microscope serves primarily to measure the dispersion of insolubles in oil, but will also show up relatively large quantities of water.

After dinner Chairman A. H. Blattner led the group in a number of old songs, and William Boyd played a number of piano selections.

Cost Chief Problem Of Commercial Jet Planes

• Metropolitan Section

Nov. 1—American aerodynamic concepts and production ingenuity are being counted on to overcome Europe's and Canada's three-to-five year lead in jet transport development, a Metropolitan Section meeting heard today. The reports came from a panel of five members of a six-man team recently returned from a Civil Aeronautics Administration-sponsored survey.

W. A. Patterson, president of United Air Lines, followed to explain that this lost time could be overcome by close cooperation of the air lines with aircraft manufacturers.

Both Patterson and the panel depicted a tomorrow of terrific speed in turbine-powered aircraft, although the economic operating ranges are still a point of controversy. Detailed study on this phase of future air transport is being studied by aircraft manufacturers and the air lines, it was disclosed.

Patterson sees nothing of commercial advantage in current military experience with jet fighters except a tremendous advance in knowledge of jet powerplants. Obviously, the actual flight experience will also be valuable to commercial air lines planning to go jet.

The Navy, he said, is probably doing the most in developing the turboprop.

Cost of jet equipment poses a major financing problem, he pointed out. From the earliest transport aircraft cost of $7,000 a ship, to the next larger type at $18,000, then a jump to $60,000 and now a million dollars for a Stratoliner, the jet jump will be somewhere between 2 and 4 million dollars each when finally in production.

"Reduced to its simplest terms, we believe that the seat-mile cost must be lowered in the future.

"At United we have started a development project on a mythical jet-transport airplane. We will write a set of requirements and turn them over to a manufacturer. We expect the aircraft builder to come up with many important improvements, just as Douglas did with the development of our specifications for the DC-6," he said.

To reduce to a minimum the lost lead time between European and U. S. development, United has retained the services of such authorities as Dr. Jerome Hunsacker, Dr. E. P. Warner, a past president of SAE, and Dr. George Mead to serve as a steering committee for the company's jet-transport development program.

It is hoped that the prototype can be built within seven years and that it won't cost more than $20 million, said Patterson, shuddering slightly.

Despite the magnitude of the problem of developing faster aircraft for the world's future commerce, the lack of man's knowledge of man appeared to Patterson as an even greater enigma.

"Management must do a more scientific job in selecting pilots.

"We always ground a ship when our instruments show that some functional part is erratic or lags in performance. Our visual inspection of parts of the structure and mechanism has been perfected to a high degree.

"But how can we detect an erratic or lagging mind, or perdict some emotional upset, that makes a sound airplane unsafe under a pilot's control?

"We are doing our level best with our medical examinations and our personnel services, but we have found no way to predict failure of human beings to function as expected," he stated.

Touching on a labor aspect of this bundle of nerves, organs and emotions known as homo sapiens, the speaker noted that this company has already spent four years and about $65,000 to fire a pilot. Union policy, which he hoped might be modified, has kept that pilot on the company's payroll despite the company's effort to bid him "goodbye."

"The good pilot can only remain a good pilot if he keeps abreast of the times. It is hard to get enough men to do that. Last year only two deaths resulted from mechanical failure of the airplanes involved, we think. The rest were caused because some function of the pilot's mind and body failed at the wrong time."

The meeting was planned and presided over by Met Section's vice-chairman for Air Transport, E. W. Fuller of American Airlines; and was preceded by a press conference of 11 reporters and aviation writers for Patterson held by S. G. Tilden, Jr., Chairman of the Section's Publicity Committee.

Sheet Steel Uniformity Important to Body Design

• Detroit Section
George J. Gaudaen

Nov. 19—A turnout of 850 attended a joint technical session of the Body and Engineering Materials Activities of Detroit Section to hear **E. S. MacPherson**, chief engineer of the Ford Motor Company, and **H. J. Cutler**, chief metallurgist of the Lackawanna Plant of Bethlehem Steel Co., discuss "Body Design and Styling as Affected by Sheet Steel."

MacPherson described the sheet steel problems which the automobile manufacturers must consider in planning and producing a new model automobile. Cutler replied specifically illustrating the steps that have been taken by the steel producing companies to alleviate many of these problems.

A basic premise in the development of a new model automobile is the weight of the car, MacPherson noted. Top management, he said, decides the price range the vehicle will sell, thus giving the engineering department an approximate idea of the eventual size and weight of the car. This makes an early estimate of the weight of the new body and sheet metal important to the designer.

With the sheet metal in the body representing 25 to 30% of the total weight of the car, he continued, the engineer's efforts are concentrated on holding this weight down without impairing the quality and the strength of the body structure. He noted that these efforts are sometimes handicapped by the variations within gages of the sheet steel received from the mill. These variations, even though they may be within the normal tolerances of 10%, can amount to differences of 60 lb on the average car. MacPherson explained that while 60 lb may not seem like an excessive amount, it can and sometimes does result in sizeable cost increases.

Cutler stated that the steel manufacturer has always been cognizant of the problems resulting from variations in gage and is constantly striving to perfect methods of maintaining uniformity. These efforts have resulted in the development of instrumentation which is lessening the variations.

An example of this instrumentation is an X-ray test gage which has been successfully applied to both the continuous hot mill and the continuous cold mill, he said. This gage gives an instantaneous and continuous indication of the thickness of the product being rolled, thereby making possible immediate mill adjustment to assure better uniformity of gage. Some variations continue to exist, despite the control, because of factors resulting from subsequent processing of the steel. Consequently, the present tables of gage tolerance represent the best current state of the art, he concluded.

MacPherson questioned the variations in the drawing quality of the sheet steel. He pointed out that often after the sheets have been blanked, they are found to have inadequate drawing quality and must be salvaged. This results in interruptions in line operations and delays in processing which end up as extra cost in the car. He acknowledged that some of the styling features on modern cars have increased the drawing problems.

Cutler explained that the drawing property of sheet steel is influenced by many factors, among which are the surface and cleanliness of the steel, its chemical composition, its grain size and arrangement, and the testing methods used. While extensive control procedures have been evolved for all of these factors, variations within them do continue to occur, he said.

The problems encountered in testing sheet steel for hardness and ductility serve as an illustration of the mill difficulties, he said. He noted that the former reliable tests for hardness (Rockwell) and ductility (Olsen) have become inadequate because the sheets are being subjected to more difficult unsymmetrical draws. The sheet mills have tried to use additional tests to gain more information on which to prejudge the sheets, but to date no test or combination of tests appears to have given the complete solution.

Sgt. Lester Coykendall of the Michigan State Police, provided an entertaining and instructive firearms demonstration at the dinner meeting preceding the technical session. He highlighted his talk on safe gun practices with such feats as slicing a playing card sideways and snuffing out candles with a revolver bullet.

"Safety First" Code Has Cut Air Fatalities

• Mid-Continent Section
L. H. Sullivan, Field Editor

Nov. 16—Safety and maintenance of commercial airlines was the subject of a discussion led by W. Paul Parsons, Braniff International Airways, Phil C. Beckman and E. P. Kovac, American Airlines.

Parsons told the group that com-

mercial airline fatalities have been reduced from 4.3 persons for every one hundred million passenger miles flown in 1938 to 1.1 in 1950. The airline companies consider safety the most important factor in planning their operations and schedules. After that comes passenger comfort, adherence to schedule and economy of operation.

Beckman gave a detailed account of maintenance and overhaul schedules of American Airlines. Work is planned so that the plane has had a complete overhaul every 11,000 hours of operation for the Convair and every 14,000 hours for the DC-6. The Convair has the best safety record of any plane in use today. Nearly every airline is currently operating or has placed orders for Convairs.

Kovak told the audience of work being done to develop new and better spark plugs. At present plugs have to be changed nearly every 400 hours, due to fouling. The maintenance depot at Tulsa uses about 10,000 plugs per month. Current investigation takes in change in design and the use of an inhibitor in the fuel, which seems to hold great promise.

Underwater Missiles Developed at White Oaks

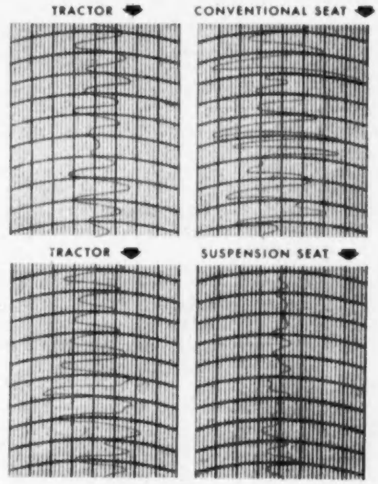
• Washington Section
Lewis C. Kibbee, Field Editor

Oct. 16—The year's program of the Washington Section started with turnout of about 150 visiting the Naval Ordnance Laboratory at White Oaks, Md. Included were a bus load of members from Richmond, among them Chairman Hutchinson.

At a luncheon in the dining room, the group was welcomed by Rear Admiral Schindler, Commander of the installation. D. E. Marlow, assistant technical director of the Laboratory, then described the missions, functions and operations of the installation. In his talk, Marlow said that the $45,000,000 873 acre laboratory employs about 3,000 persons of whom approximately 1,000 are engineers, physicists, chemists, and other scientific personnel. The major part of the laboratory work is directed toward underwater ordnance work with emphasis on development of higher speed and great accuracy. Included in the testing facilities are supersonic wind tunnels brought over from Germany at the end of World War II. The tunnels are operated by evacuating a 52-ft sphere and then allowing air to enter through a fast acting valve. By such means, Mach numbers of 8.3 have been reached by special devices. A 10,000,000 v betatron, environmental laboratories, an echo-free room, and many other testing facilities have been installed.

Motion pictures showing some of the work and testing done by the laboratory were shown. The movies included work on both the guided missile and

On the job: Proving new BOSTROM ***BODYGUARD*** "Comfort Zone" Ride. *Charts show vertical accelerations.*



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ABILITY TO STUDY the behavior of new designs in actual field service with rugged Brush Analyzers is speeding the development of revolutionary new products. For example:

Progressive engineers of Bostrom Manufacturing Company, Milwaukee, Wisc. have perfected a new suspension seat for tractors to isolate the tractor vibrations and reduce operator fatigue. The picture shows how they tested this unique product in actual riding service. Brush two-channel Recording Analyzers are located in a station wagon which travels beside a tractor equipped with the new seat. Vibration pickups—one attached to the tractor's frame and another to the operator's back—are connected through long leads to the Analyzers which record the vibrations at both points simultaneously. Results such as shown by the Brush charts at the right have given Bostrom solid facts with which to prove their product and sell it.

Versatile Brush Analyzers are giving results like this in writing for many studies . . . torque, strains, surface smoothness, temperature, d-c and a-c voltages and current and other static or dynamic conditions. Find out how these Analyzers can help solve *your* problems. Write The Brush Development Co., Dept. N-18, 3405 Perkins Avenue, Cleveland 14, Ohio, U.S.A. *Canadian Representatives:* A. C. Wickman (Canada) Limited, P. O. Box 9, Station N, Toronto 14, Ontario.

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undersea devices developed at the installation.

After the movie, the group was taken on a bus trip around the Laboratory, including the test sections. Due to its proximity to Washington, only small charges are set off at White Oaks; larger charges and missiles are sent to more isolated stations for test. Unfortunately, the turnout so exceeded expectations that the trip originally planned to several of the individual laboratories could not be made because of space limitations.

Auto Gas Turbine Not Yet Practical

• Mid-Michigan Section
Robert King Hirchert, Field Editor

Dec. 3—A practicable commercial application of the gas turbine to roadable vehicles awaits further metallurgical advancements in high temperature alloys. Both **Ralph S. Parks**, Reo Motors, Inc., and **William A. Turunen**, General Motors Research Laboratories, drew this conclusion in their discussion of gas turbine applications to automotive vehicles.

Park's presentation of the design considerations for a small gas turbine was an abridgement of the paper which recently won him the first Henry Ford Memorial Award given by the Detroit Section. A unit with a radial compressor and separate compressor and drive turbines is currently considered best for automotive applications, he said. The single turbine type does not satisfy automotive requirements due to rapid drop-off of torque at reduced speed.

Turunen's remarks were based primarily on his paper "Gas Turbines in Automobiles" presented at the 1949 Summer Meeting at French Lick.

The gas turbine offers the advantage of operating on a wide range of fuels, reduced vibration due to lack of power impulses, a simplified lubrication problem and an electrical ignition system only for starting. But it is still far from seriously competing with the present high compression ratio reciprocating engine due to the following disadvantages:

1. Fuel consumption is relatively high, particularly in part throttle operation. Improvement in this respect depends upon improvement of the various component efficiencies, the development of alloys permitting higher temperature operation and the possible use of a regeneration system to preheat the compressed air before it enters the combustion chamber.

2. Controls and limiting devices to insure safe operation need further development. Once the unit is started, speed control can be obtained by controlling the flow of fuel but safety devices to prevent excessive temperatures and speeds are essential for automotive applications.

3. The space requirement for the en-

tire installation actually appears larger than for an equivalent reciprocating engine in spite of the fact that the turbine unit itself is relatively compact. The additional bulk is taken up by air entry ducts and the relatively large cross section needed in the exhaust system.

4. Lower first cost is questionable. Although the gas turbine inherently has fewer parts than a reciprocating engine, the designs currently being considered are likely to be more costly.

5. Lower maintenance costs at present depend upon low temperature operation, which in turn decreases the over all efficiency; so it is doubtful in the current stage of development that the maintenance problem would be easily solved.

6. Because of the large volume of gases discharged from the exhaust system, it is quite probable that the exhaust stack should be pointed upwards.

7. The turbine performance is very sensitive to change in ambient temperatures and therefore would be difficult to design for the maximum and minimum temperatures encountered in automotive use.

8. The gas turbine produces no braking torque equivalent to the reciprocating engine, so it would seem almost imperative that a special device be introduced to provide this braking torque; or else the vehicular braking system would have to be greatly increased in capacity.

9. Since the construction of the turbine produces a very effective air siren, the silencing problem is acute. Fortunately most of this noise is in the high frequency range and can be effectively dampened by sound insulation material. However, the resulting sound level is still far above that considered acceptable for the conventional automobile.

10. Because of the high turbine speeds of at least 20,000 to 30,000 rpm, a relatively large gear reduction unit would be required.

During the discussion period which followed the presentation of both papers, it was brought out that the automotive power requirements are generally too low to permit the gas turbine to show its maximum advantages. In discussing the starting problems, it was pointed out that although the unit will operate with a wide range of fuels, the heavier of these tend to increase the starting difficulty. Normally, a gas turbine can be brought up to approximately 3500 rpm, after which it should be self-sustaining although the electric ignition is usually left on until higher speeds are reached. In answering a question on the possible saving in weight, Turunen pointed out that while the maximum gain could be made only with the use of lightweight material such as that used in aircraft jet engines, that for automotive use a power ratio in the order of 2 hp per pound should be possible.

Advocates Propane As Safe Fuel for Buses

• Central Illinois Section

G. W. Eger and R. F. Hughes, Field Editors

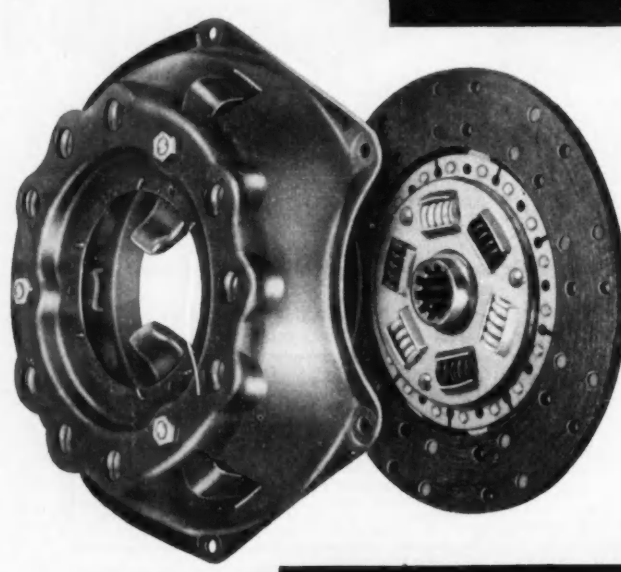
Nov. 19—**Robert S. Lee** of Twin Coach Co. told members of the Central Illinois Section that in Peoria, the home of Caterpillar Tractor Co., he was not advocating the use of propane for Caterpillar Diesel engines. Rather, he was going to confine his remarks to the use of propane as a fuel for the transit industry. He then proceeded to relate the "Propane Story" as it applied to Twin Coach buses and the Fageol engine.

Lee briefly described the Fageol engine, especially the combustion chamber, valving and manifolding which made it adaptable to the use of propane fuel.

Listing the following four points as advantages of propane as a fuel, Lee proceeded to elaborate upon them:

1. Lower fuel cost
2. Maintenance savings
3. Safety in handling
4. Public acceptance

Although fuel cost varies with locality, propane costs less than gasoline or



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In powder metallurgy, parts are die-formed to their final dimensions within extremely close tolerances. This does away with the need for machining operations which result in scrap metal.

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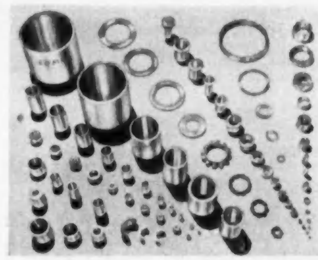
The advantages of the powder metallurgy process are of particular importance in the production of intricate structural shapes, which would normally involve extensive and complex machining, with a large amount of scrap. Gears, cams and many other parts are successfully produced, without machining, by the powder metallurgy process.

In addition to making most effective use of critical materials, the powder metallurgy process, by eliminating costly machining, reduces unit cost to the purchaser. Since the production of special shapes requires tooling, the low-cost advantage is most marked in high-volume work, where initial tooling charges are offset by subsequent savings in unit costs.



Parts such as these can be produced by the powder metallurgy process, without machining operations that result in metal scrap and increased unit costs.

COMPOSITIONS AVAILABLE

Bearings and parts can be produced in any one of a number of compositions of "COMPO" (porous bronze) or "POWDIRON" (sintered iron) either with or without self-lubrication. Detailed information may be obtained from the manufacturer, Bound Brook Oil-Less Bearing Company, Bound Brook, N. J.

diesel fuel at the refinery; and since it bears an equal share of the tax burden, it should cost the consumer less. In addition to cost per gallon saving, propane also realizes a saving by virture of the sealed fuel system which eliminates overfilling and evaporation losses.

The sealed fuel system also contributes to the safety of handling propane. Past histories of safe handling and use of propane have led to a seal of approval on the fuel by underwriters. In some instances, where this safety was recognized, the use of propane has resulted in a reduction of insurance rates.

Reduced maintenance costs, longer engine life, and more miles per gallon of oil as well as extended oil drain periods have resulted when propane was used in buses. Operating under comparable circumstances, buses burning propane fuel show an average increased engine life of 50% over buses burning gasoline. Oil consumption is improved because oil is not diluted (propane is a dry fuel) and as the oil is not washed off cylinder walls, ring and cylinder wear is reduced. Because of the slow burning rate of the fuel and high octane rating, maximum spark advance is used with propane, which increases ignition system life and reduces peak burning loads.

Propane burns clean with no smoke or offensive odor, a fact which, in this mechanical age, has contributed to its acceptance by the public as a fuel for buses.

The coffee speaker was J. M. Van Lanen, president, Peoria Engineering Council. Van Lanen spoke briefly on the aims and work of the Council.

Man-Made Rubber Will Surpass Natural

• Kansas City Section

Paul L. Dumas, Field Editor

Nov. 5—Tire salesmen of the "truth-stretching" type, who today misrepresent their product by claiming it contains more natural rubber than the law allows, will one day brag that the tire they sell is made of 100% man-made rubber. This encouraging prediction high-lighted the paper, "Tire Dollars and Sense," by **J. A. Beckett** of General Tire and Rubber Co.

Some of the developments responsible for the present high quality of tires made from manufactured rubber were sketched by the author. In 1944, General improved the batch mixing procedure by adding the carbon black while the rubber was still in the liquid form. In 1947, a competitor introduced "cold rubber", the process which enables all of the batch ingredients to be held at 41 F during actual production. Then came the high modulus furnace blacks, which further improved the tear resistance of the tread stocks and reduced the heating characteristics of the tire structure. The stature of the combined improvements

is indicated by the author's statement that passenger car and light truck tires through the 9.00 size made from these latest tread stocks provide better mileage and more freedom from tread cracking and heat blowouts than any tree rubber.

In 1950, General developed the polygen process by which 32% more rubber is produced from a given amount of butadiene and styrene than is possible under the present method. The result is obtained by adding certain petroleum derivatives to the liquid rubber and is said to produce tread stock which gives 18% more mileage than present cold rubber under identical circumstances. Production under the polygen process is underway in Canada, but is in abeyance here until the R.F.C., which controls the synthetic rubber plants, finds a formula by which General's development costs can be reimbursed.

Recently conducted surveys indicate that the percentage of truck tires removed because they are worn out is somewhere between 22% and 50%. In other words, the tire buying accounts in these surveys are getting only 22 to 50% recappable casings, and thus are tolerating a terrific waste of money. Since approximately 70% of the cost of a high-grade truck tire is in the carcass itself, tire users are obviously not cost-conscious, unless they treat the tire properly in its first tread life so as to amortize the carcass cost over subsequent recaps.

Main topics of discussion in the 45 minute question and answer period concerned the causes of premature tire failure. These continuing major causes are over-loading, under-inflation, and failure to maintain correct steering geometry. The best tire maintenance, according to Beckett, is encountered among the one- or two-truck operators and the very large fleet operators.

Light-Weight Trucks Have Greater Earnings

• Southern California Section

P. Kyropoulos, Field Editor

Oct. 18—"One pound saved in truck weight is worth $1.85 per year in additional revenue earning capacity," **Thomas D. Taylor** told a record audience of 200 at the first meeting of the season. Taylor, who is general manager of the Freightliner Corp., Portland, Ore., discussed the application of light weight metals and the coordination of mechanics and drivers' ideas in heavy duty truck design.

The paper dealt with the Freightliner WF-64 engineered and built by the Freightliner Corp. and marketed by White Motor Co. It is a cab-over-engine, dual drive chassis, designed for a maximum gross weight of 76.000 lb, in a 22 ft body and 28 ft trailer. Engines from 150 to 300 hp may be installed. Weight savings have been effected by substitution of aluminum and aluminum alloys for steel wherever possible. 2014 lb of aluminum castings, extensions and sheet are used in the construction. Great attention has been paid to cab design for comfort as well as to accessibility and ease of maintenance throughout the vehicle.

A Freightliner was available for inspection after the meeting.

Describe New 2-Cycle Diesel

• Pittsburgh Section

R. L. Sailer, Field Editor

Oct. 23—At the opening meeting of the new season, a paper was given by D. W. Radebaugh of General Motors on the design and application of the G.M. 2-cycle diesel engine. Radebaugh's paper was further amplified

by a discussion with slides by W. B. Oakley, Jr., of General Motors Diesel Engine Division, in which he requested questions and discussion from the group as he went along. The speakers were introduced by Technical Chairman of the meeting John O. Kobzina, Jr., who also acted as moderator in the question and answer period which followed and in which both speakers participated.

Many questions were asked on the performance and maintenance of this engine by the audience, some of whom had apparently had intimate experience with it in the field. Information given by the speakers in answers to questions pointed out that the absorbed blower power of the 2-cycle diesel is about the same as the power absorbed in the two pumping strokes of a 4-cycle diesel engine; that the burning of tips of injectors may be due to leakage of lube oil into the blower or to water in the fuel; that 90 cu mm injectors which have found their way into the field were specially designed for military purposes only; and that the new governor may make possible the use of higher end point fuel, but more field experience will be required before such recommendation can be made. Considerable discussion was held on the new governor characteristics which will reduce tendencies of operators toward low speed lugging.

Tribute was paid to J. E. Taylor, chairman of Pittsburgh Section for the last two years, who was presented with a scroll and a pin.

SAE Student News

Cornell University

The SAE Student Branch at Cornell held a dinner meeting on Friday, November 9 which was attended by 35 undergraduates and three members of the faculty—last year's Faculty Advisor Professor Katz, present Faculty Advisor Professor Watson and Director of Engineering Loberg. Professor Loberg presented the group with the Charter which reinstitutes the Cornell Student Branch which originally was the first that SAE had.

Chairman Bob Lewis of the Student Branch was toastmaster of the evening and introduced the speakers who included Tom Bissell and John Hollis of the SAE Headquarters Staff.

Bissell said a few words about how to participate in meetings to gain the greatest benefit, and Hollis pointed out how to make the best of current employment opportunities by not necessarily taking the first offer, but by learning what you really have to offer and getting placed where the best use can be made of your talents. Both talks were well received.

Continued from Page 72

ment of the Army to add a supplementary requirement to Specification 2-104B covering oils which had considerably increased detergent properties. This supplementary requirement was referred to as "Supplemental List 1" and stipulated that "Oils listed under this definition, in addition to meeting all the requirements of U. S. Army Specification 2-104B, must also meet the additional requirements of Specification AXS-1551 (Caterpillar 480-hr test) procedure modified by the use of 1% sulfur fuel." Supplemental List 1 states that these oils were originally developed for use in diesel engines.

Oils meeting the requirements of Supplemental List 1 generally contain about twice the amount of detergent properties as oils which merely meet U. S. Army Specification 2-104B.

Series 2

Extensive work with certain types of Caterpillar diesel engines demonstrated that, operating under exceptionally heavy-duty service conditions and using fuels of higher sulfur content, these engines required an oil with an even higher detergency than those included under Supplemental List No. 1. This lead to the development of the Caterpillar Superior Lubricants (Series 2) oils.

Then the Army set up Supplemental List 2 to Specification 2-104B. Oils listed on Supplemental List 2, in addition to meeting all the requirements of U. S. Army Specification 2-104B Supplemental List No. 1, also meet the additional and more severe requirements for the Caterpillar Superior Lubricants (Series 2) oils.

Oils meeting the requirements of Supplemental List No. 2 generally contain about twice as much detergent-dispersant additive as those which meet merely the requirements of Supplemental List 1 to U. S. Army Specification 2-104B. The additional and more severe requirements of the Caterpillar Superior Lubricants (Series 2) oils over Supplemental List 1 oils required under the above definition include satisfactory laboratory engine performance with high sulfur fuels under higher output conditions imposed by certain supercharged diesel engines.

MIL-O-2104

During the approximately eight years that U. S. Army Specification 2-104B was in effect, many different lubricants qualified. Experience indicated that some of the lubricants that first qualified were not suitable for postwar heavy-duty operation.

Therefore, a revision to Specification 2-104B was issued August 4, 1950. This revision, designated MIL-O-2104, was based at least in part on more severe engine tests using a high-sulfur-content fuel. The result was that many lubricants previously qualified

under Specification 2-104B could not meet the requirements of MIL-O-2104. In addition, many lubricants which were classified as Supplemental List 1 oils under the old specification were now included as meeting the new specification.

Supplemental Lists 1 and 2 under the U. S. Army Specification 2-104B were dropped completely. At the same time the Government stated that it did not wish specifications such as MIL-O-2104 to be referred to as "commercial standards." Since it was common practice for companies to request oils conforming to U. S. Army Specification 2-104B when purchasing heavy-duty oils for their own equipment, this request by the Government has made the picture even more complex. (Paper "Fuels and Lubricants for Heavy Duty Engines" was presented at SAE Texas Section, Dallas, March 20, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Traffic Noise Group Draws 4 Conclusions

Excerpts from paper by

PAUL HUBER

Chairman, SAE Traffic Noise Subcommittee (disbanded)

This paper will be printed in full in SAE Quarterly Transactions.

THE problem of what to do about truck noise complaints involves a number of possible phases.

First in order of time required is improvement of truck operation. If all parties involved in California were to admit the existence of large numbers of noisy trucks, and were to agree that continued operation of these trucks is essential, much could be accomplished. SAE is not the agency to make such a study, but traffic lights and boulevard stops could be modified to elminate unnecessary stops, drivers could make their accelerations in populated areas at part throttle, and routes could be laid out and built to keep through trucks out of congested areas. In other words, all concerned could plan for the use of noisy vehicles. A working committee including traffic officials, truck operators, and drivers could do considerable work along these lines.

A second phase is the improvement of the Pacific-type trucks now operating in the West and Midwest. Mufflers can be installed on these trucks, which will markedly reduce the noise. It is almost certain that the operators will have to accept a larger muffler, a smaller tailpipe, a loss in power, and greater maintenance cost. After this has been done it may be necessary to reduce other noises, but the exhaust noise is certainly the most important.

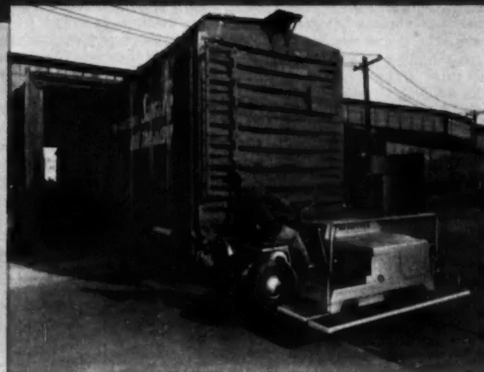
A third phase, which is relatively more important in the East, is the time pattern of trucks moving at cruising speed along comparatively level main roads, as heard in the buildings along that road. Where houses are built within a few feet of a lane in which trucks are passing at 35 mph, the rate of change of noise level is almost as bad as when shifts are made. This was not encountered in the West, but seems to be the basis of a number of complaints from New England. The only solutions appear to be to reduce greatly the noise level of the trucks, to reduce truck speeds sharply, or to widen highway right-of-ways. The latter factor should be considered in all new construction.

(Oddly enough, of all the factors involved in traffic noise, only the expedients of choosing the location of a house, setting it back from the traffic lane, and the use of screening plantings are available for use by the listener.)

A fourth phase, that of legislation

From FARM *to.....* FACTORY

New Holland Model 77 Automatic Baler picks up the hay from the windrow while neatly tied, square, uniform bales slide from the chute.



Whiting Trackmobile has two sets of wheels, one with rubber tires for ground operation and the other (at right angle) steel flanged for rail operation.

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The New Holland Automatic Baler speeds haymaking in the field, improves feed quality and saves labor in the barn. The Whiting Trackmobile combines track and road operation to cut the cost of spotting, switching and hauling railway cars.

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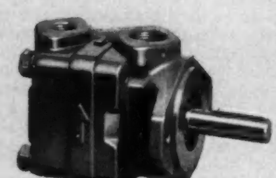

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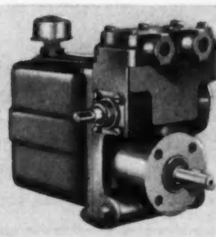

Vickers Hydraulic Power Pack consists of pump, overload relief valve, one or more operating valves, oil tank and filter. Dependable hydraulic power in a compact "package."

WRITE FOR CATALOG M-5100

4632

containing specifications for maximum noise, is not yet upon us. The Subcommittee's detailed data show that there is poor correlation between the reading of an ASA noise meter and judgment of noise. The use of a 600-cps high-pass filter improved the correlation a little, while the use of the three-band meter devised by the Subcommittee greatly improves it, if one sets limits on the three bands independently. We are of the opinion that it would be difficult to support standards of quietness measured only by an ASA meter, if the law were attacked vigorously in court. The three-band meter would stand a much better chance of surviving. But the use of the three-band meter for this purpose will require a great deal of survey work, accompanied by jury tests to determine the practical limits of noise measured in each band. (Paper "Report of Automotive Traffic Noise Subcommittee" was presented at SAE National Transportation Meeting, October 16, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Railroad Cuts Cost Of Diesel Lubrication

Based on paper by

L. C. ATCHISON

Denver & Rio Grande Western RR Co.

A RAILROAD operating 130 diesel units, each holding 200 gal of oil in its crankcase and traveling 12,000 miles a month, cannot spend $156,000 a month changing oil every 1000 miles, as recommended for cars. Nor can it take the oil companies' advice to drain every 20,000 to 30 000 miles. Such advice seems to rest on the idea that the terrible things that ruin oil appear to occur just before the recommended drain period, regardless of mileage.

So Railroad Tests Oil

All that is normally found in crankcase oil is dust, dilution, water as the result of blowby and subsequent condensation, and the breakdown products of the oil and fuel. If a program of testing the oil tells the operator how much of these various detrimental items is present, he can use the oil until some one item becomes excessive.

In our setup, the first and most frequently used test is for flash point. On large diesels, dilution indicates leaking lines, dribbling injectors, or improper timing, and it is essential that corrective action be taken quickly to avoid crankcase explosions.

The second test is the ASTM precipitation number, or per cent dirt determination, while the third test is for ash content of the oil. When the ash is analyzed, using a spectrograph as the most convenient tool, the amounts of additive metal, wear products, and soluble dust constituents can be studied and an approximation of the wear rate can be determined.

This test program in conjunction with other work and ideas has enabled us to have in use 94.5% of all the EMD liners we have ever purchased, irrespective of mileage or age. It has been a large factor in reducing the RGM's 1946 parts bill of $176,000 to $53,000 in 1950—a reduction of 70%. Being essentially a no-drain program, it has saved over $50,000 annually on the oil bill.

In all cases it is essential that the oil, the testing of the oil, the overall engineering, and the maintenance practices be sound, if optimum results are to be obtained. (Paper, "Railroad Diesel Engine Lubrication," was presented at a meeting of the SAE Colorado Group, May 22, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price 25¢ to members, 50¢ to nonmembers.)

New Members Qualified

These applicants qualified for admission to the Society between Nov. 10, 1951 and Dec. 10, 1951. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (SM) Service Member; (FM) Foreign Member.

Atlanta Group

Lloyd W. Moore (M).

Buffalo Section

Robert James Collins (J), J. Gerald York (J).

Canadian Section

James Douglas More Gray (M).

Central Illinois Section

Charles Ernst Ballard (A), Gordon J. Mason (A), Warren Ross Salzman (J).

Chicago Section

William E. Broadfoot (J), Robert T. Daily (A), Victor R. Farlow (M), Donald E. Ferro (J), William Benjamin Gross (J), Ralph Stephen Hajek (J), F. Marion Hogue (M), Eugene H. Middendorf (M), Walter J. Moeller (M), R. J. Packard (J), George M. Tam (J).

Cincinnati Section

Howard L. Finn (J), Robert K. Ruehrwein (A).

Cleveland Section

Frank Hribar, Jr. (J), George B. Josten (J), Charles F. Laundy (J), P. J. Reeves (M), Harold Emil Riedel (J), John W. Spring (J).

Colorado Group

Murray B. Chidester (J).

Dayton Section

Alfred W. Carey, Jr. (J), George H. Harris (A), Earl R. Kunz (M).

Detroit Section

Gerald N. Bergum (J), Harold E. Boettger (J), F. H. Bourke (M), Richard L. Exler (J), Daniel Wolf Feldman (J), L. T. "Larry" Flynn (M), Robert T. Herdegen, Jr. (M), Victor J. Hurych (J), Bruce Edmond Lamm (J), Philip W. Lett, Jr. (M), Allen E. Light (J), Walter L. Luptowski (J), William Cram Morgan (J), Robert L. Nance (J), Russel H. Nutter (J), D. C. Richardson (A), Rapha R. Rolph (A), Rene E. Sauzedde (M), David Joseph Sharp (J), Ralph L. Skinner, Jr. (A), Aram Sogoian (J), Donald B. Tipping (J), Hugo H. Traeger (A), Richard A. Vining (J), Thomas Joseph Wilkinson (J), Charles M. Wright (A), Walter C. Zetye (J).

Hawaii Section

Edward R. Kuwaye (A).

Indiana Section

Kenneth Walter Berner (J), James D. Sauer (J).

Metropolitan Section

Peter L. Crown (J), Joseph D. Fina (A), Hugh Harvey (M), Jesse R. Hollins (M), Melvin M. Hyams (J), Joseph Klein (J), Avram Moreno Mechoulam (J), John Mockovciak, Jr. (J), Reginald William Pauley (J), George Francis Sheridan (A).

Continued on Page 111

New Members Qualified

Continued

Mid-Michigan Section

Adolph F. Braun (M), Henry F. Wiebrecht (M).

Milwaukee Section

James G. Darby (A), John Arthur Langley (J), Milton G. Mardoian (J), Norman Paul Mollinger (M), Robert J. Muzzy (J), Robert Edward Schaefer (J), Dana J. Schneider (A), Joseph A. Zerkel (M).

Montreal Section

Robert L. Dunsmore (M), I. Finkelstein (M).

New England Section

Harold A. Connor (A), Robert G. Douglass (A).

Northern California Section

Eugene B. Kent (J), Roland James Wolfe (A).

Northwest Section

Robert Olaf Ringoen (J).

Oregon Section

Stanley F. Kinne (J), James A. Oeder (M), Rege A. Ott (A), Lyle R. Patterson (A).

Philadelphia Section

John Morgan Richards (M), Asa Edward Snyder (J).

Southern California Section

Gene R. McLaughlin (J), Randall Weston Richards, Jr. (A), Marvin Earl Russell, Sr. (M), Earl W. Seely (J).

Spokane Intermountain Section

Edward W. MacKenzie (A).

Syracuse Section

William Arthur Brown (J), Richard A. Sturley (A).

Texas Section

Robert John Armstrong (J), William L. Jenkins (M), Kenneth D. Mills (J), O. H. Stelter, Jr. (J).

Wichita Section

Kaye Charles Heller (J).

Williamsport Group

Heinz F. Moellmann (M).

Outside Section Territory

Charles Henry Dawson (A), Alvin Verle Haptonstall (J), John Frederick Hendel (J), Warren W. McCaw (M), Charles Theodore Pabian (J), Lloyd Douglas Smith (M), Thomas H. Wilkenson (SM).

Foreign

Peter Bonde Andersen (FM), Scotland; Frederick W. Clarke (FM), England; Frederick John Pascoe (FM), England; Mufti Mohammed Salim (FM), Pakistan.

Applications Received

The applications for membership received between Nov. 10, 1951 and Dec. 10, 1951 are listed below.

Atlanta Group

McClelland Berston, Howard F. Steiner.

Buffalo Section

Herbert A. Franke, Fred Kurt Kunderman.

Canadian Section

Neil D. Gaskin, Lloyd Calvin Secord, Arthur S. Walker.

Central-Illinois Section

John Richard Brown, H. Dale Clark, Edward James Guthmann, Donald W. Knopf, Errol D. Rodda, Gilbert Tribley, H. M. Williamson.

Chicago Section

William Clyde Buzzard, Charles O. Engels, Donal C. Ertel, Franklyn A. Glassow, LeRoy A. Grotto, Charles A. Lease, John W. Pocock, Ronald H. Witt, Robert E. Wahlstrom.

Cincinnati Section

Warren M. Custer, Joe E. Mellen, Philip D. Newell, Jr.

Cleveland Section

Jack R. Allen, Ronald Gombert, Roy W. Hull, Alfred Arthur Hurschman, Gordon J. Nicholas, David B. Prescott.

Colorado Group

Hugh M. Connors, Lowell M. Higgins, Logan Nelson Ragle.

Detroit Section

Kenneth R. Alter, James L. Carlisle, Robert S. Cluff, Daniel S. Crishon, William Christensen, Arthur S. Cromie, Harold R. Fitzgerald, Joseph A. Fortin, James J. Glander, Lynns Gruesbeck, Lawrence G. Harshfield, Carl S. Hoffman, Rudolph Jansa, Allen C. Kaiser, Alvin Peter Kruthers, Clifford G. Likes, Duncan McPherson, Jacque H. Passino, Thomas C. Peerey, Vaino W. Pennanen, John D. Porter, Edward C. Rembecki, Joseph V. Rogers, Charles E. Scheffler, George August Schmidt, Karl Schwartzwalder, Eugene R. Shull, Harry Morgan Starlin, Otis M. Stover, Carl S. Taylor, Charles W. Tremor, Vernon Stephen Yerebeck.

Hawaii Section

Kenneth M. Blume, George M. Wheelwright.

Indiana Section

James A. Hardy, Charles Albert Lewis, Jr., Albert F. Wilcox.

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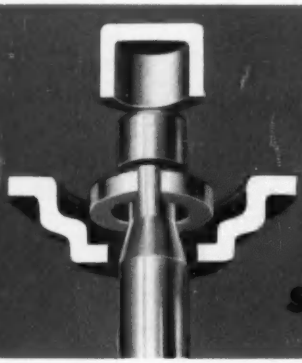

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EATON

Eaton Free-Valves can be applied to practically any engine without design changes. Eaton engineers will welcome an opportunity to discuss the application of Eaton Free-Valves to engines proposed or now in design.

Eaton Free-Valve Kits for Motor Cars, Trucks, and Tractors are available from dealers.

The Eaton Free-Valve is free of any restraining force set up by the spring, other than the normal vertical components necessary to control the rise and fall as dictated by cam motion. During a major portion of the lift cycle, valve motion is controlled, but the valve is free to float within the limits of the free-valve clearance.

This free-floating action keeps deposits from building up on the stem, guide, or seat faces. It also provides the motion necessary to keep a film of oil on the stem and guide surfaces, preventing scuffing and excessive wear. With the elimination of restraining forces, the normal tendency of the valve to creep causes it to take variable positions with respect to the seat at successive lift cycles.

The principal effects of this unrestricted motion are as follows:

1. Deposits commonly built up on the stem at the port end of the guide are continually wiped away.
2. Seat deposits are more uniform, and are held to a minimum.
3. Building up of excessive temperatures from local leakage due to deposits or distortion is prevented.

Performance records covering engines of all types in all kinds of service prove that Eaton Free-Valves can and do increase valve life by as much as *ten times* over the ordinary life expectancy of conventional valves. Write us for proof.

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Applications Received

Continued

Metropolitan Section
Donald W. Bedell, William John Flach, Francis Louis Gallant, Elbert E. Husted, III, William H. Lawrence, Eric Schwarz, Herbert R. Taylor, George F. Wildermuth.

Mid-Continent Section
Robert A. Forsman.

Mid-Michigan Section
Frank William Ball, Jr., Alexander Brede, III, Gerald K. Chase, Charles D. Holton, Arthur C. Lillrose, Andrew W. Zmuda.

Milwaukee Section
John Henry Forsberg, Burton A. Hostnick, David Henry Jamieson, Norman Lyle Timmcke, Lewis Edmond Williams.

Mohawk-Hudson Group
Shethar Davis, Stanley H. Proffitt.

Montreal Section
Jean Claude Lanoie, Charles E. Marceau, A. T. Sherpitis.

New England Section
Allister William Shepherd.

Northern California Section
Charles R. Carmichael, George F. Choate, Fran E. Kronenberg, William Ortman Lampkin, William W. Robinson, Dr. Vanderveer Voorhees.

Northwest Section
J. C. Johnson, Roy A. Martin.

Oregon Section
F. E. Davis, Oren E. Ross.

Philadelphia Section
Hamilton M. Artley, Herman Duchin, William C. Hollibaugh, Raymond L. Johnson.

Pittsburgh Section
William H. Gould.

St. Louis Section
R. S. Curry, Jr., Herbert R. Dippel, Walter H. Reiser.

San Diego Section
Ira J. Hassap.

Southern New England Section
Marcus J. Gottsche, Jr., Stuart A. Woodward.

Southern California Section
Norman S. Petersen.

Texas Section
Harold C. Anderson, Kenneth P. Campbell, Monroe F. Kent, L. C. W. Patton, Jr.

Virginia Section
Ashton Gustave Broaddus, Lawrence E. Sizer.

Washington Section
Lawrence Wilbur Froyd.

Western Michigan Section
Louis D. Carufel.

Wichita Section
Henry T. Biehl.

Williamsport Group
Henry T. Young.

Outside of Section Territory
Charles Boatner Anders, Jr., Kenneth Crawford Bowman, J. Fred Callahan, Jr., H. K. Dommel, John Daniel Gleeson, Jr., Kenneth J. Harris, Francis A. Mallery.

Foreign
Ernest Edward New, England; T. K. Sitaram, India; Cornelius Willem Stants, Holland.

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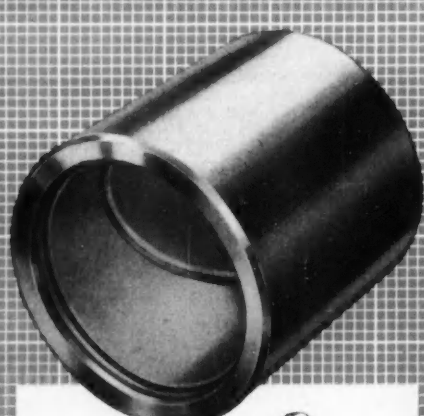

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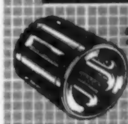

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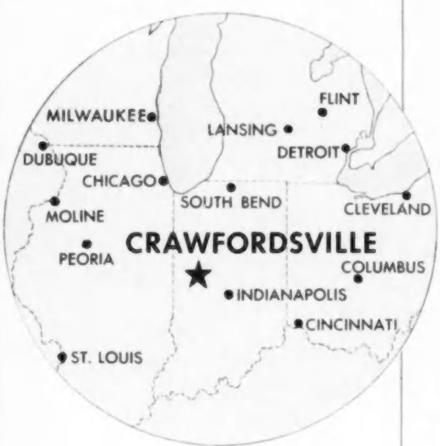
for tanks and other military vehicles and for the aviation, agricultural and automotive industries and other precision parts of powdered metal will be manufactured at the Wabash Division.



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of Raybestos-Manhattan, Inc., is designed and equipped from the ground up with the finest facilities and most modern machinery for the manufacture of sintered metal friction elements.

INVALUABLE BACKGROUND

in setting up this new division was provided by thirteen years' experience in making similar sintered metal parts at our Raybestos Division, Bridgeport, Connecticut. Manufacture of these products will continue at the Bridgeport plant.

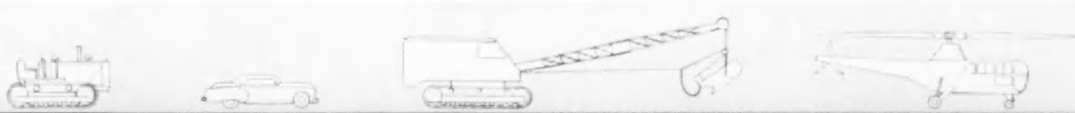
STRATEGIC LOCATION

of the new Wabash Division reduces delivery time to automotive-manufacturing and defense work centers of the Midwest: Detroit, Chicago, Milwaukee, South Bend, Cleveland, Peoria, Indianapolis, St. Louis, Cincinnati.

EXPANSION OF THIS DIVISION

was part of the planning when the sixty-two-acre tract was acquired. Additional buildings will provide manufacturing capacity for other Raybestos-Manhattan products at some future date.

OTHER DIVISIONS AND PRODUCTS OF RAYBESTOS-MANHATTAN, INC. ARE LISTED ON THE FOLLOWING PAGE



OTHER RAYBESTOS-MANHATTAN MANUFACTURING DIVISIONS AND PRODUCTS

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Brake Blocks, Molded and Woven

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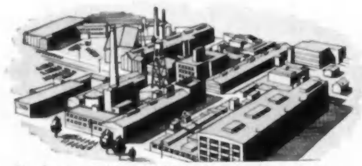
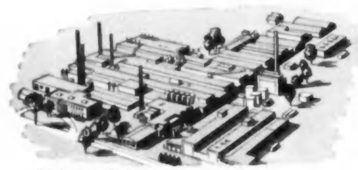
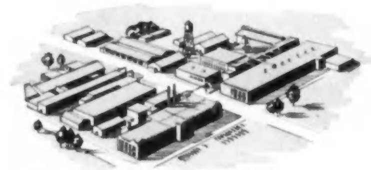


Manhattan Rubber Division, Passaic, New Jersey
(Branch Plant – Neenah, Wisc.)

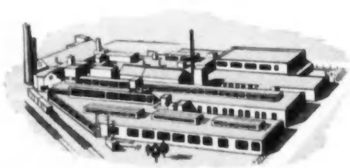


Raybestos Division
Bridgeport, Connecticut

U.S. Asbestos . . . Grey-Rock Division
Manheim, Pennsylvania



General Asbestos & Rubber Division
North Charleston, South Carolina



Canadian Raybestos Company Ltd.
Peterborough, Ontario

ANOTHER *new* DEVELOPMENT by ZOLLNER

"NI-RESIST" IRON TOP RING SECTION

BOND LOC*

FOR EXTRA HEAVY DUTY SERVICE

PISTONS

Double Bonded

METALLURGICALLY Al-fin Bond

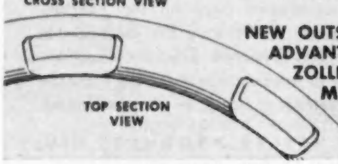
MECHANICALLY Zollner Lock

Now, another great advancement in piston design is made available to engine builders by Zollner engineers. It's the new BONDOLOC Piston for heavy duty engines where excessive top ring groove wear has been a problem. A "Ni-resist" iron groove section is *permanently* incorporated in this piston by *both* Al-fin metallurgical and Zollner mechanical bond — *double bonded and locked* to positively prevent separation failure in any service. The exclusive Zollner mechanical lock with reverse angles on every surface joining "Ni-resist" iron and aluminum provides a multiple dovetail bond which is infinitely wedge-locked. Zollner engineers invite immediate discussion of the many advantages of BONDOLOC Pistons by application to your engine.

CROSS SECTION VIEW

FRONT SECTION VIEW

INSIDE SECTION VIEW



TOP SECTION VIEW

NEW OUTSTANDING ADVANTAGES OF ZOLLNER DESIGNED MECHANICAL LOCK

1. Reverse angle designed top ring section with tapered flutes dovetail locks in all directions.
2. Positive mechanical interlock prevents any movement.
3. Reduces weight 25% to 30% with lower inertia stresses.
4. Increases surface areas carrying inertia load.
5. Provides visual inspection of bond as seen in ring groove.

Licensed under Patents 2,396,730; 2,455,457; 2,550,879.

*T.M. Reg. Pat. App. For

ZOLLNER

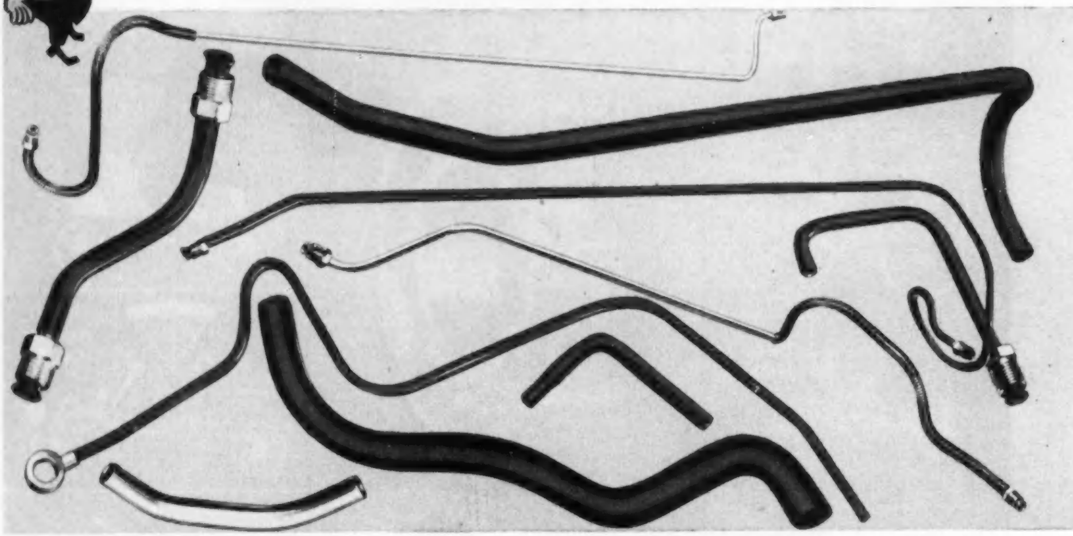
- ADVANCED ENGINEERING
- PRECISION PRODUCTION In Cooperation With Engine Builders

The Original Equipment **PISTONS**

ZOLLNER MACHINE WORKS • FORT WAYNE, IND.


M-R-C BALL BEARINGS
Selden's Motor Wagon 1877
Duryea's Motor Wagon 1895
Ford 1896
Winton 1898
Packard 1899
Rambler 1902
Since 1898
MRC
The first M-R-C Ball Bearings were made especially for automobile pioneers before the turn of the century
1952
For over 50 years M-R-C has been an important factor in the development of the automotive industry.
Autocar 1902
Studebaker Electric 1904
Stanley Steamer 1908
Buick 1908
Maxwell 1908
Model-T Ford 1908
Hudson 1909
MARLIN-ROCKWELL CORPORATION
Jamestown, N. Y.

Your greatest automotive

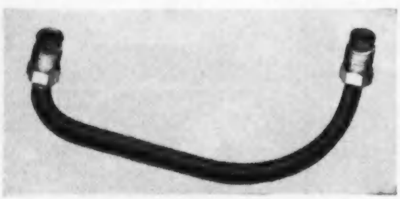


FABRICATION SAVINGS

Shooting for lowered manufacturing costs, better automotive performance in your new designs? Bundy engineers can help work out the easiest, most practical ways to fabricate new lines and tubing parts in double-walled Bundyweld. Often make substantial *extra* savings by showing how to use less tubing, where to take production short-cuts. You save because Bundy men "can do!"

COSTS CUT

You save in the constant search for lowered production costs on your specific automotive part at Bundy. Fabricating the bead and bend in oil level indicator above formerly required two separate operations. Now the two are combined in one Bundy-engineered step, and costs of unit reduced accordingly.



PRODUCTION SAVINGS

You save in the continual improvement of basic production steps within Bundy, as well. Assembly of flare nuts in end-to-end alignment on tubing lengths, as above, formerly a tedious hand operation, is now expedited by Bundy-developed automatic nut assembler. Savings go right on to Bundy customers.

PERFORMANCE SAVINGS

You save, too, with Bundyweld's dependable, trouble-free, *safe* performance the life of your automotive equipment. Sturdy, more resistant to failure from vibration, extra-rugged and -strong, Bundyweld is used in the fuel, oil and brake-line systems of 95% of today's cars . . . evidence of its dependability.

tubing buy on every count

Tubing features second to none, priceless, time-proved, safe performance, plus engineering skills that cut costs to the bone, *yours* when you specify Bundyweld Tubing

When specifying tubing for brake lines and other automotive applications, look beyond the question of cost-per-foot. Look at *all* that you buy in Bundyweld Tubing

In the last 20 years, 360,000 miles of Bundyweld Tubing have been used in the brake-line systems of cars, trucks, tractors and buses in all price ranges. You buy *safety*, proved in the billions of miles traveled by these vehicles.

Here is the only tubing double-walled from a single strip, copper-bonded through 360° of wall contact. No other tubing has all of Bundyweld's features because of this one-of-a-kind design. Bundyweld is extra-sturdy and -strong, highly resistant to brutal shock and vibration fatigue. You buy the world's finest automotive tubing, feature-wise.

Bundyweld hits your assembly lines clean as a whistle inside and out . . . as specified, and on time. Either prefabricated by Bundy, or in lightweight, easy-handling lengths ready for fast, economical fabrication by your men. In fabrication, in deliveries, you buy unsurpassed engineering skills and services that mean savings in the long run.

Price-conscious, or performance-conscious—or both—the world's finest automotive engineers know there is no adequate substitute for Bundyweld Tubing.

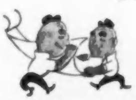
There can't be. No other tubing is like it.

Contact a Bundyweld Distributor listed below, or write direct to *Bundy Tubing Company, Detroit 14, Michigan*

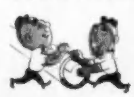
Bundyweld® Tubing

DOUBLE-WALLED FROM A SINGLE STRIP

WHY BUNDYWELD IS BETTER TUBING



Bundyweld starts as a single strip of basic metal, coated with a bonding metal. Then it's . . .



continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Bonding metal fuses with basic metal, presto—

Bundyweld . . . double-walled and brazed through 360° of wall contact.

NOTE the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave. South ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 881 Bay St. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

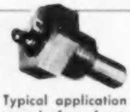
Bendix-Friez THERMISTORS

(NEGATIVE TEMPERATURE CO-EFFICIENT CERAMIC RESISTORS)

THESE temperature responsive resistors are useful as temperature measuring elements and as liquid level sensors; they are especially well suited to compensation where the circuit constants must be maintained irrespective of temperature changes. Since they are a fired ceramic, they are stable under practically all conditions and respond only to temperature changes.

BENDIX-FRIEZ STANDARD ROD TYPES

Size (inches)	@ +30°C.	@ 0°C.	@ −30°C.
.140 x ¾	45 ohms	88 ohms	193 ohms
.040 x 1.5	14,000 ohms	29,946 ohms	74,676 ohms
.018 x 1.5	40,000 ohms	94,040 ohms	262,400 ohms



Typical application in capsule form for temperature sensing of hydraulic oil.

Many other values can be obtained from standard diameter material. Because the thermistors are made in our own plant, under extremely careful control, special compositions, shapes, and resistance values, hermetically sealed or otherwise protected, can be made in any quantities to suit your individual requirements.

We invite your Inquiries

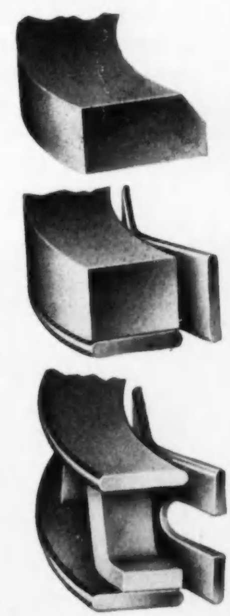
Write Dept. D

FRIEZ INSTRUMENT DIVISION of
1324 Taylor Avenue • Baltimore 4, Maryland
Export Sales: Bendix International Division, 72 Fifth Ave., N.Y. 11, N.Y.

Bendix AVIATION CORPORATION

"Made for Each Other!"

SERVICE PISTON RING SETS BY MUSKEGON



Muskegon serves car manufacturers by working with them to design piston rings especially for their engines. By this close collaboration each ring and its companion rings, each set of rings and its corresponding engine are truly "made for each other" and will work smoothly together to produce top performance, mileage, and economy.

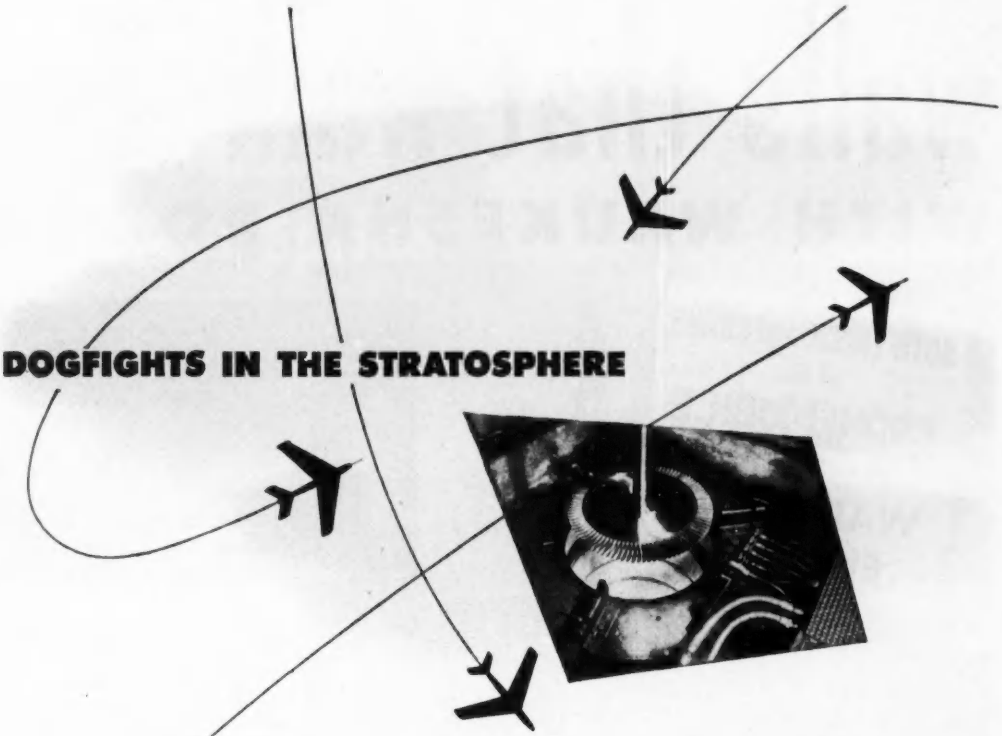
Muskegon offers car manufacturers *complete* service—not only design and engineering, but the most modern facilities for the casting, processing, finishing, inspection, and packaging of Service Piston Ring Sets.

These *Factory Approved* and *Factory Engineered* Service Piston Ring Sets are available only through car dealers and other authorized service outlets.

MUSKEGON
Piston Rings

MUSKEGON PISTON RING CO.
MUSKEGON, MICHIGAN
PLANTS AT MUSKEGON AND SPARTA

"THE ENGINE BUILDERS' SOURCE"



DOGFIGHTS IN THE STRATOSPHERE

...are previewed in our whirl-pit

The jet fighter pilot who suddenly has to have a few extra pounds of thrust reaches for his throttle confidently.

In our whirl-pit, we spin each Thompson-built jet-engine turbine at 1¼ times normal full speed. It's another way to be sure that the precision-forged buckets will stay with the turbine wheel when there's a call for extra thrust.

We had a large part in developing the metals and the processes that help make a jet engine live longer, and that make it a better engine.

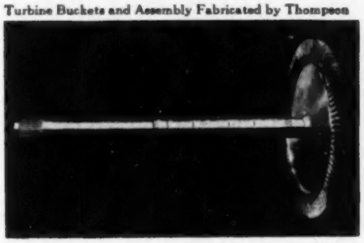
We know a great deal about alloys and how they behave under 1500° of heat at 10,000 rpm.

We have also developed processes to finish-forge complex air-foil shapes to final blueprint dimensions, eliminating the need for more costly operations.

Perhaps there will be need for this kind of knowledge and this kind of precision in a product you're dreaming of . . . if there is, we'll welcome the chance to talk with you.

YOU CAN COUNT ON THOMPSON FOR ENGINEERING LEADERSHIP

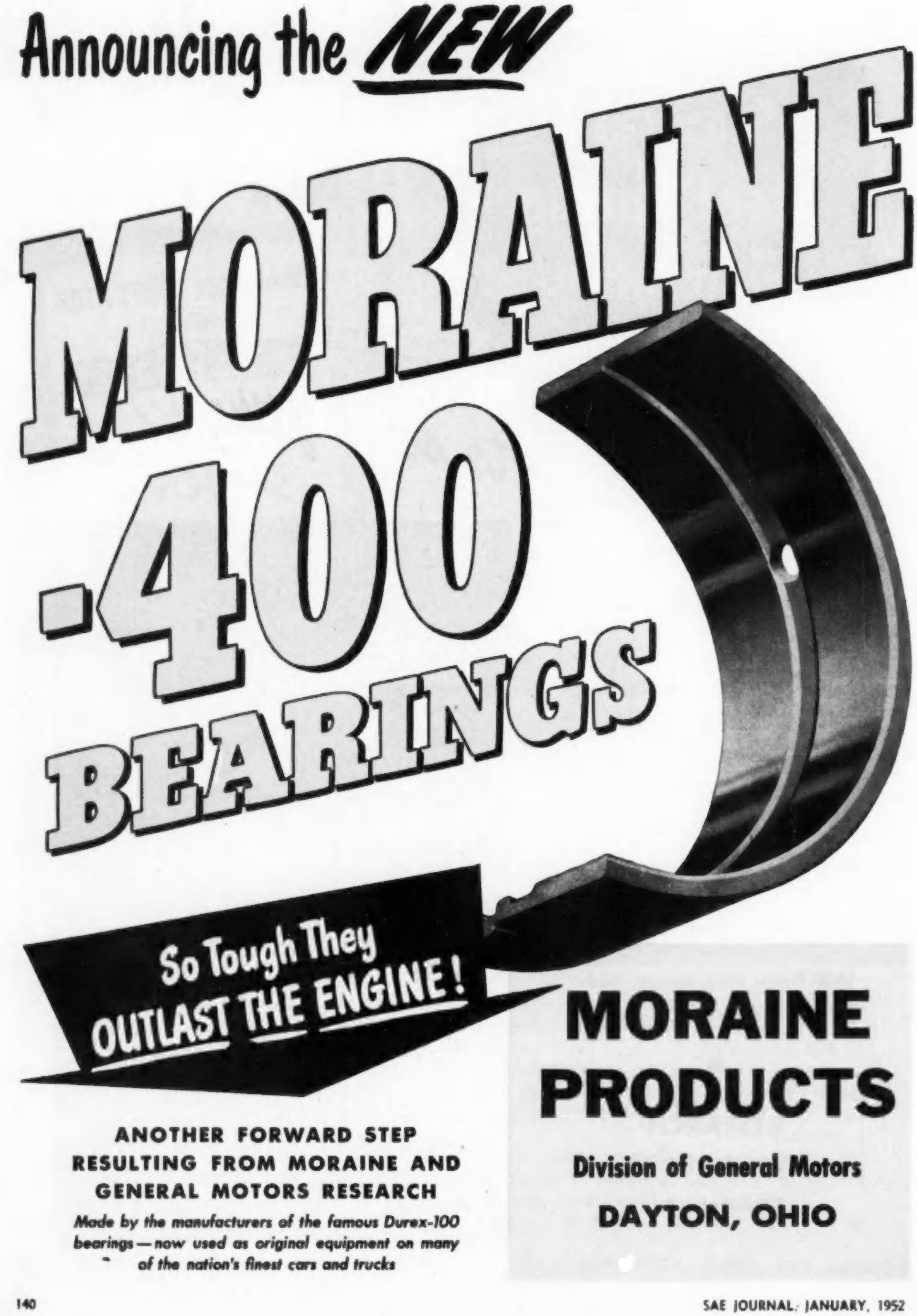
Turbine Buckets and Assembly Fabricated by Thompson



JET DIVISION

Thompson Products, Inc.

EUCLID, OHIO


Announcing the NEW
MORAINE
-400
BEARINGS
So Tough They
OUTLAST THE ENGINE!
ANOTHER FORWARD STEP
RESULTING FROM MORAINE AND
GENERAL MOTORS RESEARCH
Made by the manufacturers of the famous Durex-100 bearings—now used as original equipment on many of the nation's finest cars and trucks
MORAINE
PRODUCTS
Division of General Motors
DAYTON, OHIO

30,000-FOOT ANSWER TO YOUR GROUND-LEVEL HEADACHE

Look to the sky for the answer to valve troubles on your truck, industrial, and off-the-road engines . . .

The same principles of valve design and fabrication that help make aircraft engines fly higher, faster, and longer between valve overhauls can be applied to your engines.

Sodium-cooled valves operate at lower head temperatures and last hundreds of hours longer without burning . . . Thompson-developed high-heat-resistant alloys prevent untimely warping and distortion of valves. Thompson designs tailor the cooling capacity of the sodium-filled valve to the needs of the engine.

Thompson engineering provides the best valve to handle severe operating conditions. We'd like to explore the adoption of sodium-cooled valves with your engineers.

VALVE DIVISION

Thompson Products, Inc.

EUCLID, OHIO

YOU CAN COUNT ON THOMPSON FOR ENGINEERING LEADERSHIP

Industry Comes to Aetna

for two important reasons :

TO SAVE MAN HOURS, MACHINE HOURS AND MONEY

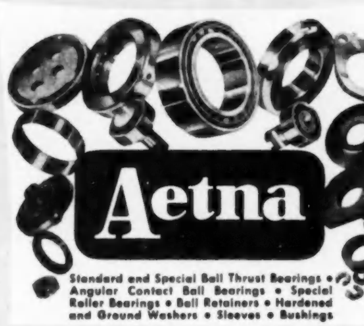
TO HELP GET THINGS DONE

Today the pressure for production is on. The welfare of our economy —or of an individual business—may depend upon a deeper search for time and money-saving methods.

Take your own plant, for example. Maybe there's a lot you could save—some bottlenecks you could break—by letting Aetna fabricate certain of your assembly parts . . . to your most exacting metallurgical, uniformity and tolerance specifications. You'll avoid troublesome raw material procurement problems, decrease the burden on over-loaded equipment, save man-hours and very likely reduce the delivered cost of your product to boot.

Aetna's mobilized facilities include the most modern equipment for stamping, piercing, machining, heat treating, ultra precision finish grinding plus complete engineering assistance, extensive tool and die facilities and over 35 years experience in serving leading manufacturers in the Automotive, Agricultural Equipment, Oil Field Equipment and General Industrial Fields.

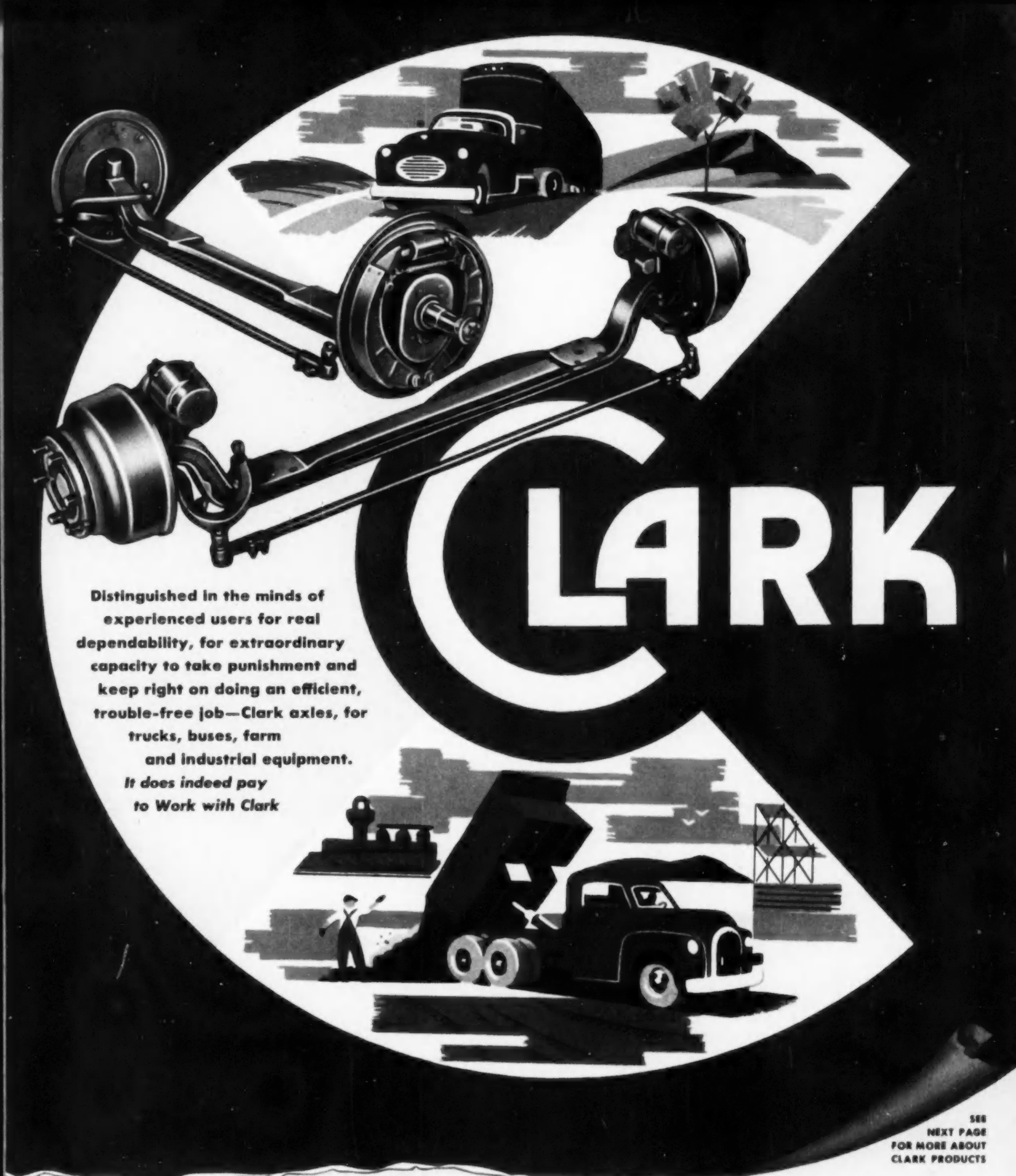
NOW is a good time for YOU to find out how Aetna can help with your parts problems as well as your bearing problems. Write today!



AETNA BALL AND ROLLER BEARING COMPANY

4600 Schubert Avenue, Chicago 39, Illinois

In Detroit: SAM T. KELLER • 2457 Woodward Avenue



CLARK EQUIPMENT COMPANY, Buchanan, Michigan

Other Plants: BATTLE CREEK AND JACKSON, MICHIGAN


Pin Point Service -
in the great Spring Using Area of America...
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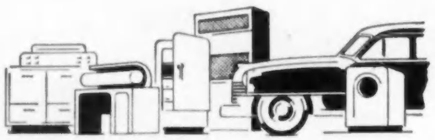
THE WALLACE BARNES COMPANY LTD.
HAMILTON, ONT. CANADA
DIVISIONS OF
ASSOCIATED SPRING CORPORATION
AND CANADIAN AFFILIATE

How many of <u>you</u> use

Here is a list of the most important Parker Products used in the metal working industry today. It's an expanding list, growing as Parker research develops new products to broaden the field of metal treatment.

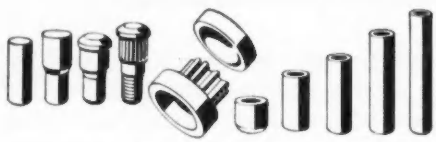
Some of these products add durability and protect appearance by anchoring the paint and controlling corrosion. Another enhances performance and prolongs the life of wearing surfaces. Others bring important benefits to production lines, making new techniques practical, improving conventional operations.

Every Parker Product listed here has proved itself. Each one is formulated and manufactured to the high Parker standard of quality to work for you with highest efficiency, dependability and economy.



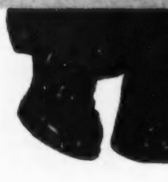
☐ BONDERITE

The standard surface preparation method for metals to produce paint finishes of highest quality. Bonderite converts the surface to a nonmetallic phosphate coating, integral with the metal, which is an excellent anchor for paint and an effective corrosion resistant. An adaptable product, simply applied in spray or immersion equipment, easily controlled for dependable results. Used widely, on the world's most famous and admired manufactured products.



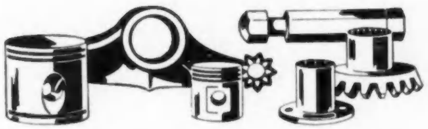
☐ BONDERITE AND BONDERLUBES

Cold forming of metals is faster, easier, and more economical of time and metal because of this proven combination. Bonderite and Bonderlube combine to form a lubrication system that makes metals flow smoothly, lengthens die life, cuts metal loss. Years of experience are behind this Parker development—90% of all seamless steel tubing (and millions of feet of welded steel tube) is drawn with Bonderite. Many Ordnance items are now being manufactured with this aid.



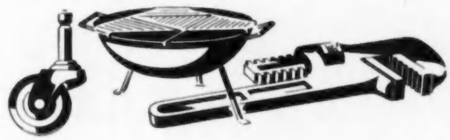
**Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.*

these PARKER PRODUCTS do to make your metal products better?



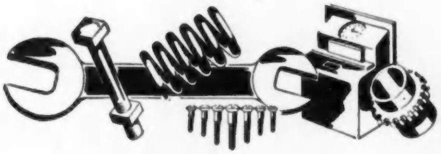
☐ PARCO LUBRITE

On gears, cylinder walls, pistons, rings, shafts, valves and rods, Parco Lubrite is used to create a nonmetallic phosphate coating on the metal. This coating holds lubrication under pressure, prevents metal-to-metal contact and resulting scuffing and scoring during initial operation. The smooth, easy break-in with Parco Lubrite makes for longer subsequent service life.



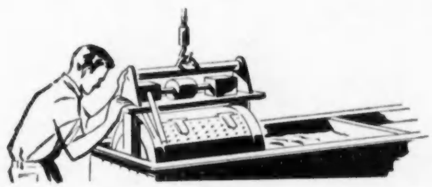
☐ PARCO COMPOUND

For 35 years, this Parker product has meant quality rust resistance for iron and steel. The dense crystalline phosphate coating becomes integral with the metal and forms an excellent base for rust preventive oil or paint finishes. Any iron or steel article, small or large, simple or complex, may be treated with Parco Compound.



☐ PARCOLACS

A useful group of specialized products made up of various finishes for use after Parco Compound. Includes wax base finishes, stains, and rust preventive oils suitable for dip, spray or centrifuge application. Available for quick or slow drying requirements. Parcolacs add desirable appearance and performance qualities to articles treated.



☐ PARCO CLEANERS

An outstanding line of metal cleaners formulated to condition the metal for the next step in finishing, as well as to remove grease and soil efficiently. Alkali, acid, and emulsion types, each formulated to meet certain conditions of soil, production requirements, and finishing operations which follow.

PARKER PRODUCTS MEET GOVERNMENT SPECIFICATIONS

Parker RUST PROOF COMPANY, DETROIT 11, MICH.

Mail this coupon today!

Please send me information on products checked:

- ☐ Bonderite
- ☐ Bonderite and Bonderlube
- ☐ Parco Lubrite
- ☐ Parco Compound
- ☐ Parcolacs
- ☐ Parco Cleaners

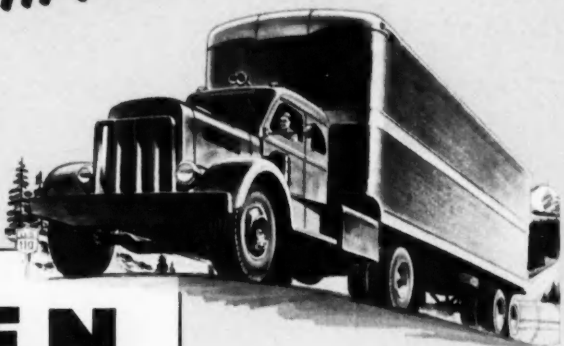
PARKER RUST PROOF COMPANY
2181 E. Milwaukee, Detroit 11, Michigan

NAME ____________________

FIRM ____________________

ADDRESS ____________________

Pictured is the Chase XC-123
— prototype of the C-123



Bendix Products Presents

TREADLE-VAC

A REVOLUTIONARY ADVANCE

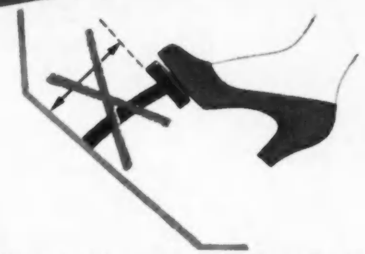
Now passenger car manufacturers can offer braking that is comparable to the accelerator in operating ease, convenience and fatigue-saving comfort for the driver. Treadle-Vac gives an entirely new type of passenger car brake control, using the proved operating principles of the Bendix*Hydrovac,* the world's most widely used power brake. An easy ankle movement, much like working the accelerator, is all the physical force needed for normal braking. And what is equally important, the brake treadle can be on about the same level as the accelerator, so that the foot moves from one control to the other by simply pivoting on the heel. Thoroughly proved by years of testing, this latest development of Bendix engineers gives car manufacturers an opportunity to offer their customers *for the first time* the easiest, safest, and smoothest braking that can be imagined. From the standpoint of both appearance and performance, it is one of the finest new selling features available in years. Get the detailed story of this greatest advance in passenger car control since four-wheel brakes.

*REG. U. S. PAT. OFF.

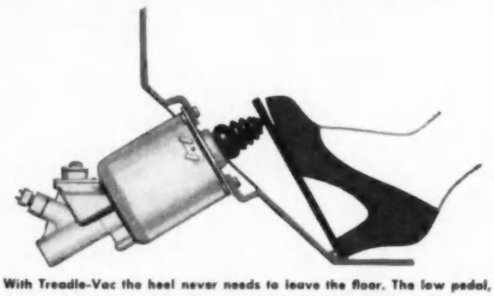
BENDIX · PRODUCTS DIVISION · SOUTH BEND

BENDIX AVIATION CORPORATION

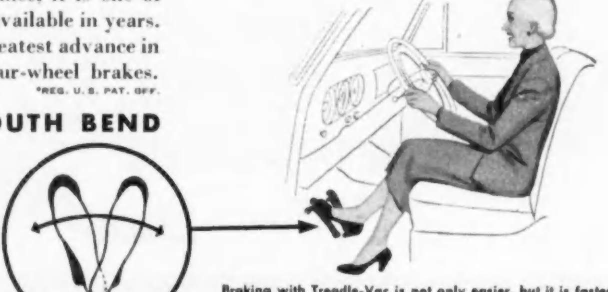
Export Sales: Bendix International Division, 72 Fifth Ave., New York 11, N.Y. • Canadian Sales: Bendix-Eclipse of Canada, Ltd., Windsor, Ontario, Canada



The old fashioned, long travel, high brake pedal requiring a lifted foot and leg power pressure can now disappear from the floor boards of modern cars.



With Treadle-Vac the heel never needs to leave the floor. The low pedal, short travel and toe touch action mean that the swing from accelerator to brake can be made merely by pivoting on the heel.



Braking with Treadle-Vac is not only easier, but it is faster as well. Shifts from "go" to "stop" control are made in one fourth less time. This can mean five feet shorter stopping distance at 60 miles per hour.

—A Low, Light-pressure Brake pedal

Comparable to the

Accelerator in Operating Ease!

2 NEW SAE REPORTS...

——SP-68—Inverted Tooth (Silent) Chains and Sprocket Teeth (ASA B29.2-1950). Standardization of silent chains, based on standardized sprocket tooth design. Allows interhangeability of chains on sprockets of any number of teeth. Data tabulated for ease of reference.

SAE Members—$1.00 each
Non-Members—$2.00 each

——SP-69—Transmission Roller Chains and Sprockets (ASA B29.1-1950). Consolidation and revision of previous roller chain and sprocket standards, allowing interchangeability. Partial interchangeability with British standards.

SAE Members—$1.50 each
Non-Members—$3.00 each

——ORDER BLANK——

Society of Automotive Engineers
29 West 39th Street
New York 18, N. Y.

Please send me —— copies of SP-68 and —— copies of SP-69.

——CHECK or COUPONS ENCLOSED
——Bill Company
——Bill Me

Name: ....

Company: ....

Company Address: ....

....

the truth about Dow Corning Silicones...

. . . is more fantastic than the patter of the pitchman or the spiel of the barkers that doubled in advertising and sales a generation ago. For example:

- **Silicone (Class H) electrical insulation makes motors and other kinds of electrical equipment last 10 times as long as they ever did before.**
- **These same insulating materials are used to double the power per pound ratio in electric machines.**
- **Silastic,* the Dow Corning silicone rubber is used to seal hot air at 600°F., hot oil at 350-400°F., limit switches and bomb bay doors at —100°F.**
- **Dow Corning Silicone oils and greases make permanent lubrication a practical reality.**

To many engineers and executives, such silicone facts as these still sound too good to be true. That's why we have built and assembled 16,000 pounds of demonstration units and typical applications to prove that our silicone products will do all that we claim for them. This is the first comprehensive Silicone Exposition ever assembled. Previewed in Washington, D. C. during the week of October 22nd, this exhibit will be given private showings in major industrial centers across the country.

DOW CORNING SILICONE EXPOSITION
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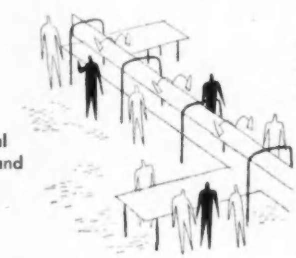

If you want to know more about this Exposition write for complete information including our new 32-page book which answers in simple words and pictures, the $64 question, **"What's a Silicone?"** Address Department **V-13**

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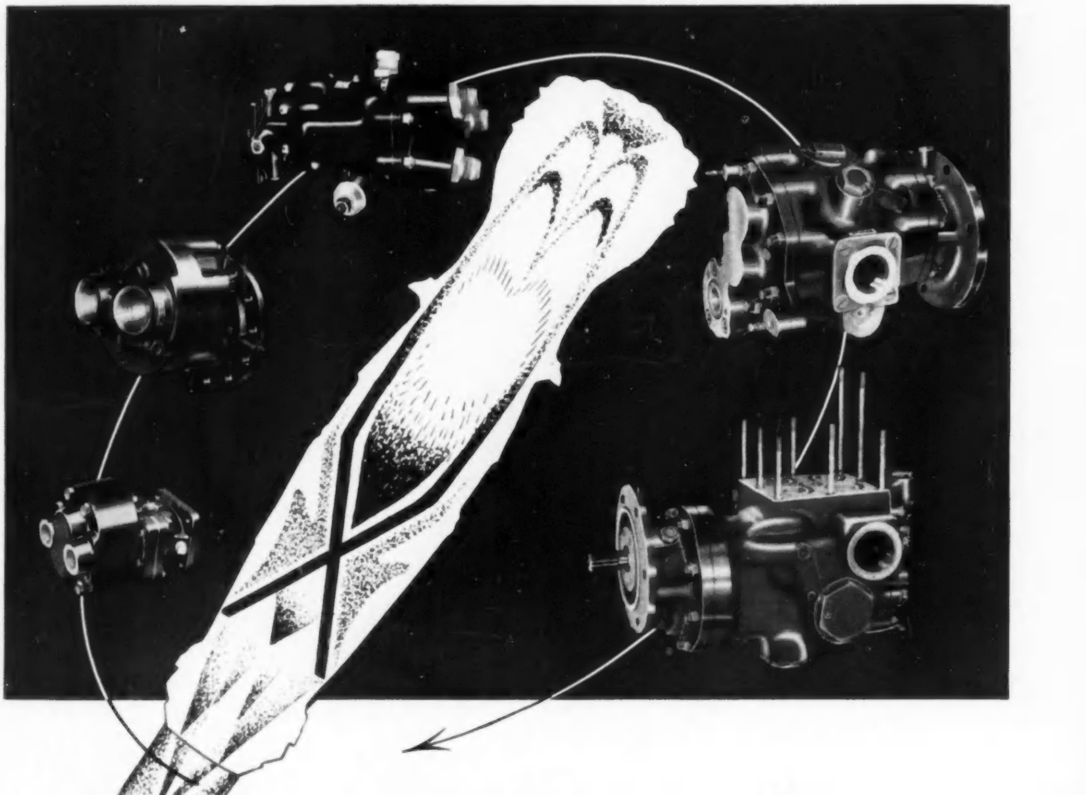

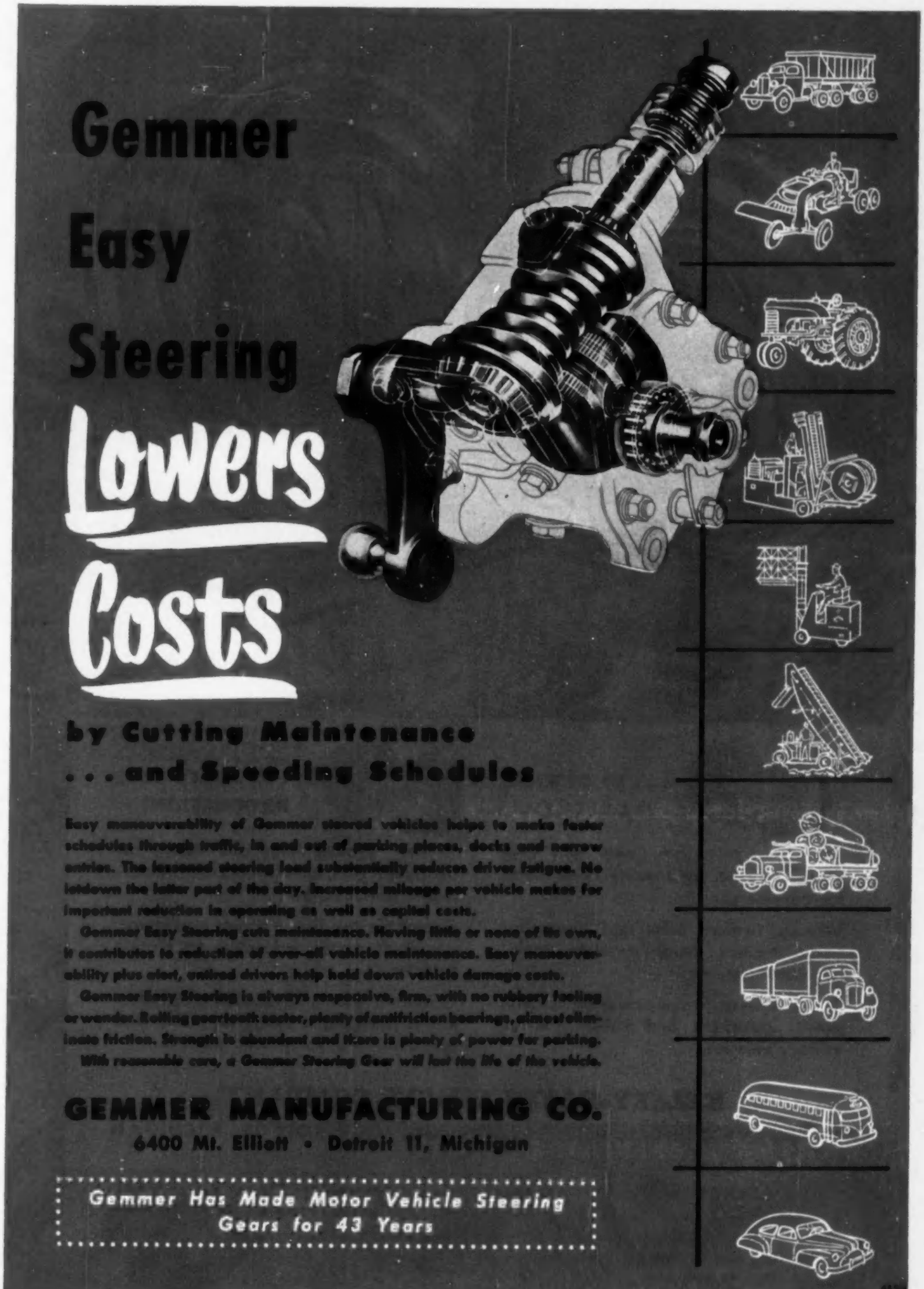
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How United Air Cleaners

Get <u>Outside</u> Air <u>Inside</u> the Engine

High under-the-hood temperatures that cause vapor lock can be a real headache to truckers — particularly when high summer temperatures aggravate the situation. That's why United Specialties air cleaner designers working in close cooperation with Diamond T engineers developed a special oil bath air cleaner to combat this condition.

This air cleaner is mounted on the inside of the hood ventilating louvers in such a way that *cool outside air* is drawn into the carburetor instead of hot under-hood air. Thus the United Oil Bath Air Cleaner not only provides air that is over 99 percent dirt free, but also aids in eliminating vapor lock.

The above case is typical of many instances where United Specialties engineers are called upon to provide specialized air cleaner service. It is one of the reasons United builds over 260 different air cleaner models. We invite *your* inquiry.

Here is Diamond T truck Model 720 which is equipped with the louver-mounted air cleaner illustrated. United Specialties Company, working closely with Diamond T engineers, have pioneered in air cleaner designs utilizing outside-the-hood air.

UNITED SPECIALTIES COMPANY

UNITED AIR CLEANER DIVISION • CHICAGO 28
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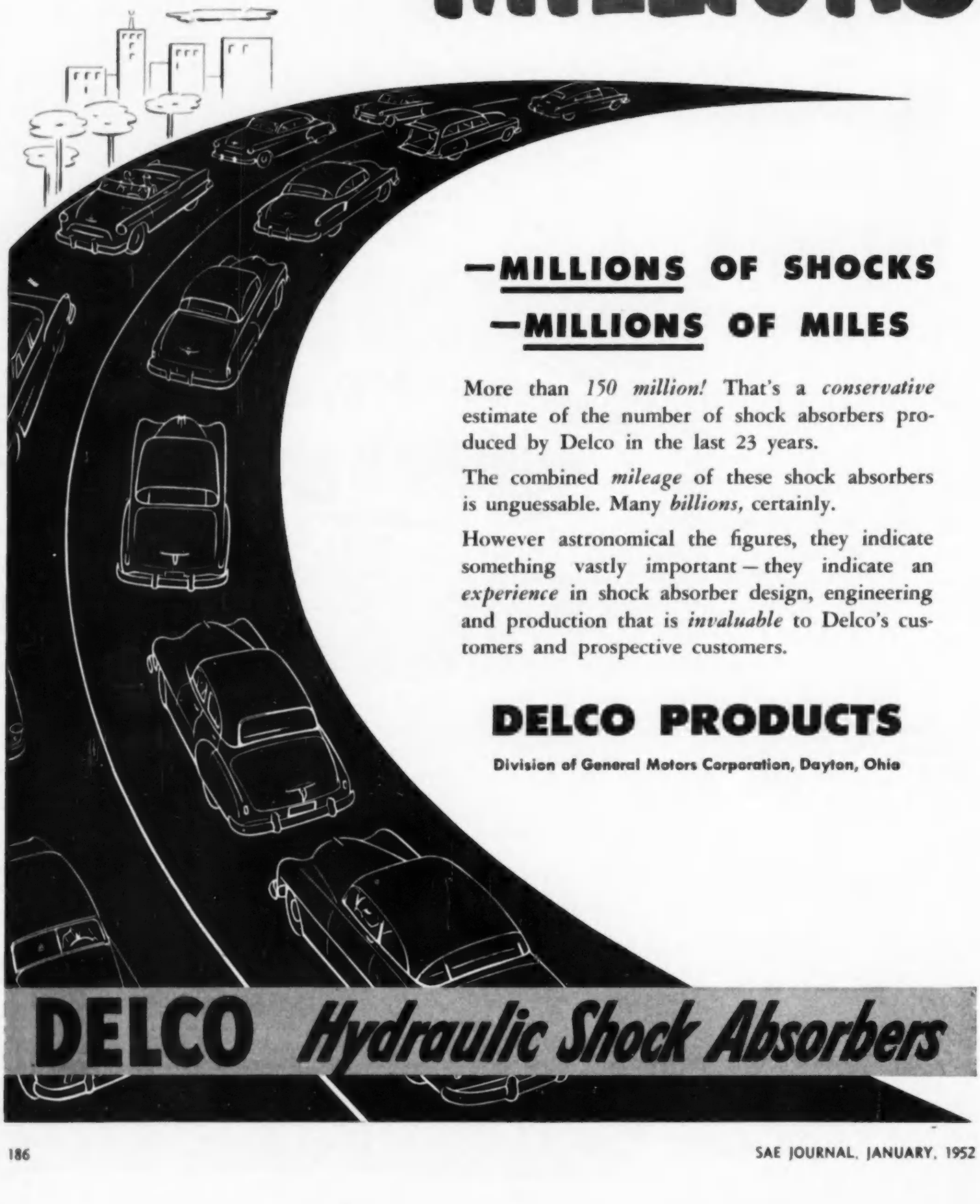

. . . *to Build Every Type of*
SHEET METAL DIE

The 1000 ton press shown in the background of the above illustrations is one of a number of try-out presses of varying capacities in operation in Richard Brothers Division die shops. This particular press, with a bed measuring 120" by 204", has capacity for tryout of extremely large dies. Many other types of equipment, including ten duplicating machines, give Richard Brothers the facilities to produce sheet metal dies of virtually every size and type.

Here, too, are the men who know how to use this equipment — men with years of experience and proven ability in die design and die building. When Allied equipment and manpower go to work for you, you can be sure of dies that will give you maximum production and economy.

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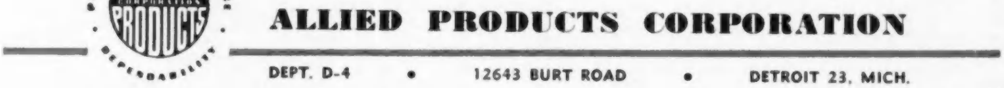

PLANT 1 Detroit, Mich. — PLANT 2 Detroit, Mich. — PLANT 3 Hillsdale, Mich. — PLANT 4 Hillsdale, Mich.

+ INDEX TO ADVERTISERS +

+ INDEX TO ADVERTISERS +


Oil Foil
LUBRICATION
SEALING
In many machines, such as motors, pumps, hydraulic cylinders, bearings, etc., it is important not only to lubricate operating shafts, but to seal the assembly completely. OilFoil washers offer an efficient way of performing both functions.
OilFoil washers consist of one or more layers of felt, bonded with one or more septums of Hycar, the synthetic rubber-like substance that is impervious to and unaffected by oils, greases, and hydrocarbons used in hydraulic systems. These seals are available in various types, according to individual needs. In one type, for example, the outer layer of felt acts to exclude dust; next a septum of Hycar acts as the outer oil retainer. The next layer of felt is impregnated with lubricant for constant lubrication of the shaft. And finally, the inner septum of Hycar is an additional oil seal.
These seals were originally developed by American Felt in 1921, and since then the only major improvement has been the adoption of the new material, Hycar, in recognition of the severe leakage or seepage problems brought about by the newer hydraulic fluids and lubricants. OilFoil seals offer the ultimate in protection. They are supplied cut to exact dimensions, ready for assembly. As a rule, they require no attention between major overhauls.
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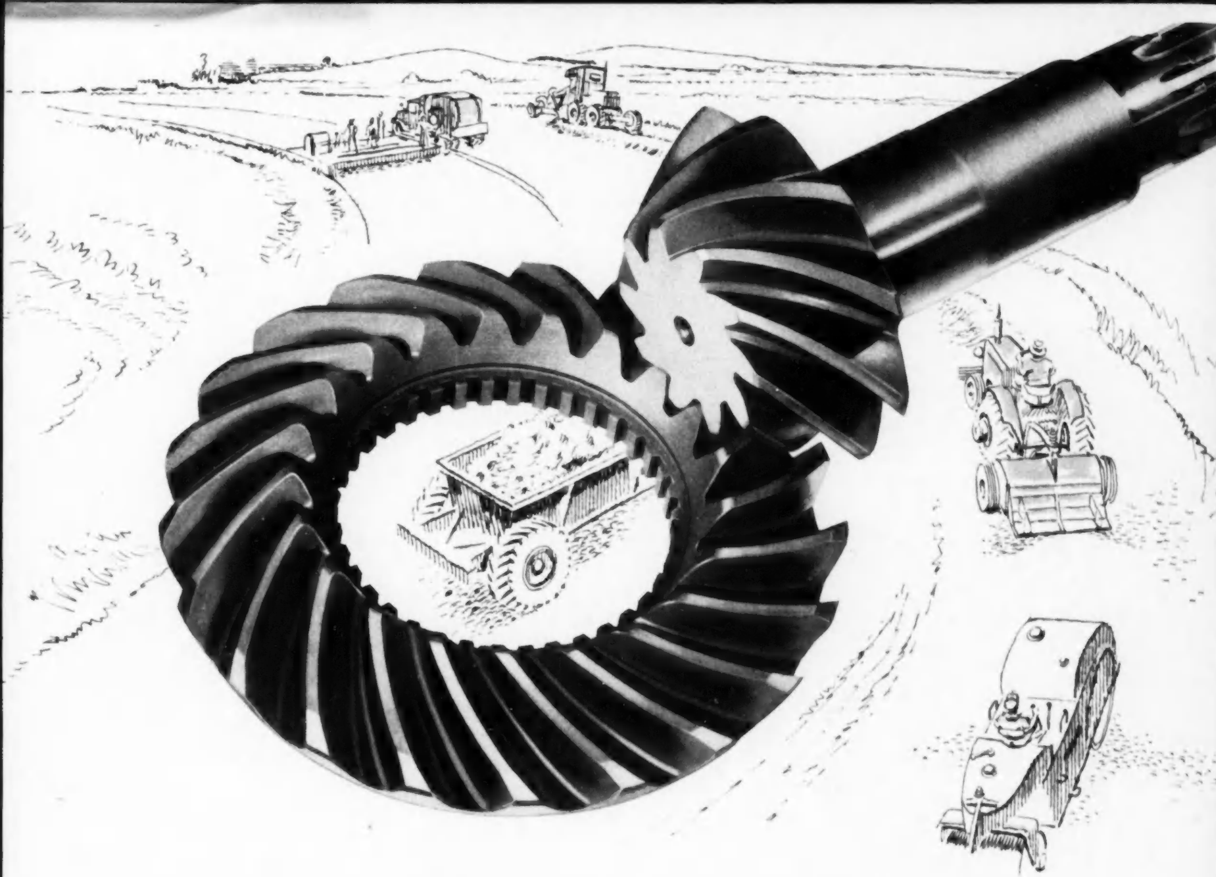

Another needed mile of progress in the making!

There are approximately 1,700,000 miles of improved highways in America. Huge as that number seems there must be many, many more miles if America is not to lag for want of highways where its swift wheels can safely travel.

Development of modern road building machinery has greatly accelerated the pace of road building and repairs. Machines now do in hours the work that required days not long ago. In many of these machines "Double Diamond" Gears are used to transmit the tremendous power needed for grading, rolling, scarifying, paving, and hauling. Few kinds of equipment place greater loads on gears—none are more unrelenting in demands for work-horse performance without costly breakdown or time out for service.

The fact that "Double Diamonds" are used in such a variety of road building machines may be worth remembering when you're on the lookout for gears that *dig in and deliver* with a notable degree of dependability.

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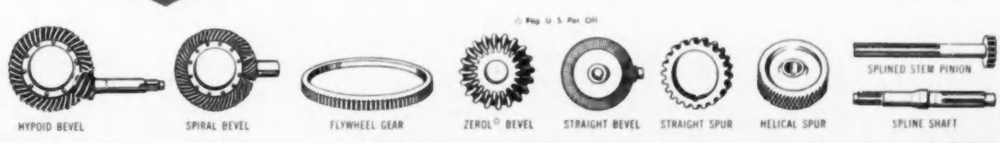

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